



The Blast Furnace and Steel Plant

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The Blast Furnace ^{and} Steel Plant

VOL. IX.

PITTSBURGH, PA., NOVEMBER, 1921

NO. 11

Modern Sintering Plant of the Cambria Steel Company

A Description of Complete Installation of Large Capacity and of Rugged Design, Completely Equipped with Labor Saving Machinery, Ample Unloading Facilities and Large Storage Bins.

By H. V. SCHIEFER

WORKING from preliminary designs of the Cambria Steel Company, Arthur G. McKee & Company, Cleveland, has designed and erected a complete sintering plant at Johnstown, Pa., for the sintering of a large stock of flue dust on hand and to sinter the flue dust as produced.

With the present freight rates on ore from lake ports, this plant will effect appreciable economies in the production of pig iron.

The plant embodies two of the large size Dwight & Lloyd sintering machines. The entire plant is equipped with the most improved type of machines for reducing labor to a minimum incident to the handling of over 1,000 tons of material daily.

The entire plant covers an area of about 80 ft. by 300 ft. Advantage is taken of a hillside location to eliminate the installation of an expensive trestle. Not only is a trestle eliminated, but an area of otherwise useless space is occupied to advantage.

The plant is designed for the production of 800 tons of sinter per day. It is arranged so that stock pile flue dust, direct flue dust or a mixture of the two in any proportions may be used. Mill scale and ore may also be used if desired. Duplication of machinery is installed insofar as possible so that a shut down of one piece of equipment will not shut the plant down.

Raw material is brought to the plant in standard gauge railroad cars on two tracks that are about 40 ft. higher than the finished sinter tracks. Two unloading track hoppers are provided. Each hopper has a horizontal area of 30 ft. by 30 ft. and accommodates two cars, making a preliminary storage of eight carloads in and on the hoppers. The unloading tracks extend on a ledge around the hill so that at least 25 cars may be spotted beyond the track hoppers and allowed to coast

into position on the hoppers.

The entire top area of the hoppers is covered with a heavy cast iron safety grillage. The openings in the grillage are about 4 in. by 5 in., which eliminate the possibility of a workman falling into the hopper. At the same time it prevents large lumps and all large foreign objects from dropping into the hopper and plugging the feeders below. The grillage is made heavy enough to allow for the breaking up of frozen flue dust with sledges in the winter. The track hoppers are covered over with a steel house sheeted top and sides. Windows are provided located high enough up to prevent breakage and to allow for good lighting.

The track hoppers are of steel plate. At the bottom of each is provided an opening equipped with a rack and pinion gate for regulating the flow of material from same.

Under each gate a slow moving conveyor is placed. Each of these conveyors consists of two strands of extra heavy roller chain between which overlapping steel pans are attached. Flue dust is received at times containing as high as 12 per cent, making the design of a self feeding conveyor of importance. These conveyors act as feeders as well as conveyors. They are placed at an angle of

about 25 degrees from the horizontal, are about 60 ft. long and discharge into two revolving screens.

Years of experimenting have been done in trying to successfully screen all kinds of flue dust. The screens as installed are taking the material as it comes and have proven their worth. The screens are of the revolving center shaft type and are a truncated pyramid in shape with six sides. The screen cloth, which is made up of $\frac{3}{8}$ -in. wire, is mounted on frames that are easily removable. Structural steel trolley beams are located directly over the screens to expedite repairs. The screens are 4

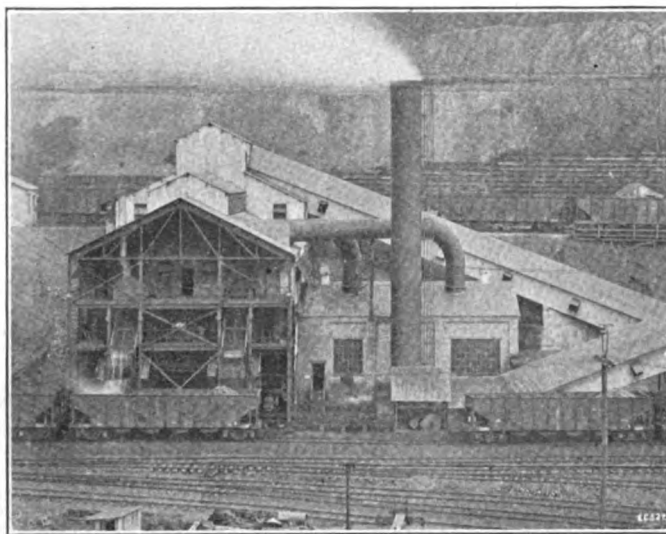


Fig. 1—Discharge end of sintering plant.

ft. in diameter at one end, 6 ft. at the other end and 12 ft. long and mounted on 6-in. shafts.

The over-size coke that is screened out of the flue dust drops into other bins and thence along through chutes to railroad cars. This over-size coke can be sent to the furnaces and used as fuel.

Each screen is driven by a direct connected 25-hp motor. The conveyors are driven through gearing and a clutch from the screen shaft. All of the gearing as well as the entire screen is enclosed in heavy steel guards for protection to workmen and to prevent dusting.

The unloading and screening equipment will handle 1,000 tons in 10 hours, thereby cutting the unloading labor to a day turn of 10 hours only. To permit this, four storage bins are provided with a total capacity of 640 tons, which will supply the sintering machines for the 14 hours that the unloading gang is not working. There are six storage bins in all; two under each of the two screens

case in previous designs where a bevel gear and pinion were utilized. As the disc revolves the material is brought against a scraper which directs it through a 7x9-in. opening in the side of the feeder. This opening is fitted with an adjustable sliding door so that the discharge of the material may be regulated. The feeders are all driven from one line shaft and any one or all may be cut out by means of clutches.

The discharge openings from all feeders are arranged to discharge onto a 30-in. belt conveyor. This belt conveyor and all feeders are driven by a variable speed motor. The variable speed is necessary since the speed of the sintering machines is occasionally changed, requiring more or less material.

By the manipulation of the gates in the feeders any desired proportions of materials may be obtained and at the same time a preliminary mixing is obtained. The 30-in. belt discharges the proportioned material on an in-

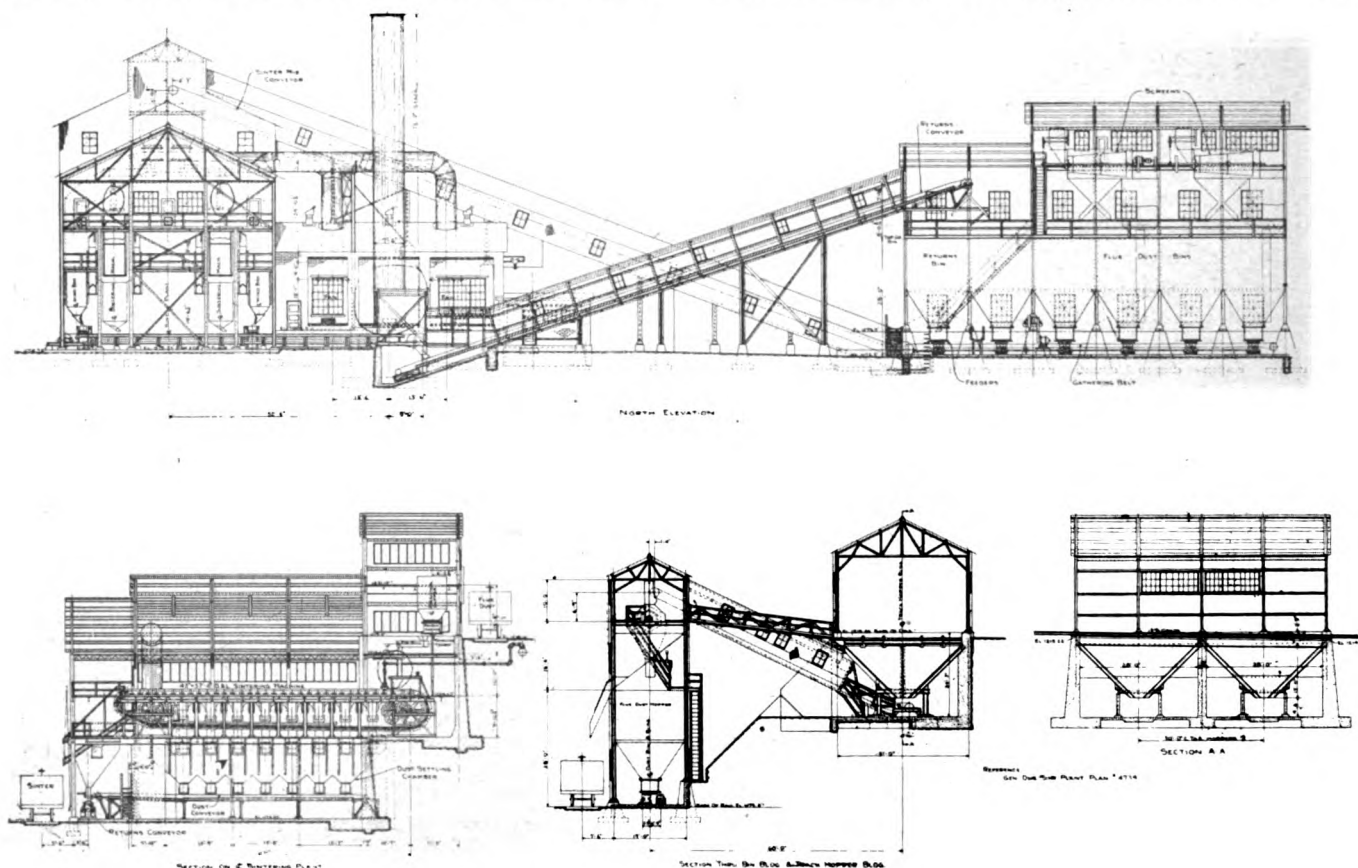


Fig. 2—Section through the new plant.

for flue dust and two provided for returns to be described later. These bins are all placed in a straight line. Each bin is provided with a standard McKee revolving disc feeder. To eliminate the difficulties encountered in previous feeders for this work, a feeder of new design has been provided that is extremely rugged and designed to take up the wear incident to the material handled. Each bin bottom is fitted with a cast iron cylinder, open top and bottom, 48 in. in diameter and 30 in. high with an opening in the side provided with an adjustable slide gate. Directly under the cylinder is placed a horizontal revolving disc made of $\frac{3}{4}$ -in. boiler plate. This disc is bolted to a spur gear and is driven through a vertical shaft provided with a bronze thrust bearing. As the thrust bearing wears the spur gear simply slides further along the teeth of the driving pinion. This was not the

inclined belt conveyor that carries the material to the top of the plant and discharges into a super hopper.

The super hopper acts as a reservoir only and would be unnecessary if it were practically possible to run the entire plant in positive synchronism. The bottom of this hopper is bifurcated and is fitted with two McKee revolving disc feeders that are duplicates of the ones under the storage bins except that they run at a higher speed.

From the point where the material leaves the super hopper the plant is divided into two complete units, each consisting of a pug mill, a sintering machine, fan, and the necessary auxiliaries.

The feeders under the super hopper are driven from a counter shaft of the sintering machines and work with them in positive synchronism so that a speeding up of

the sintering machines automatically speeds up the feeders. A change of hearth bed depth is accomplished by an operating lever located on the operating floor which raises or lowers the opening in the feeders.

From the feeder the material drops into a McKee pug mill which thoroughly mixes the various ingredients. Water is added in the pug mill to give the proper consistency necessary for sintering. The pug mill is a cast iron trough about 12 ft. long in which two square shafts revolve in opposite directions. Manganese steel paddles are mounted on the shafts. Ball-bearings running in oil are used to take the thrust. The shafts are equipped with couplings so that they may be quickly removed without disturbing the driving gear. The bottom may be dropped and cleaned while the mill is in operation.

The pug mills are extremely heavy with an entire cast iron frame and were designed and built by Arthur G. McKee & Company. Each pug mill is belt connected to a 20-hp motor. The pulley shaft is at right angles to the paddle shafts of the mill and the transmission is effected by means of bevel gears.

grates which travel under ignition burners and over wind boxes equipped with downdraft suction fans. These machines have an effective grate area 42 in. wide and 57 ft. 4 in. long. The old standard Dwight & Lloyd machine was 42 in. wide and 25 ft. 6 in. long, and the lower strand of pallets rolled by gravity along an inclined track back to the driving sprocket wheels. The much greater length of these new machines makes the use of a gravity return undesirable and the lower strand of pallets is, therefore, positively driven along the lower track by sprocket wheels at the discharge end. These discharge end sprocket wheels are driven in synchronism with the driving and sprocket wheels. This synchronous drive insures that the empty pallets are returned to the driving sprocket wheels at the same rate of speed as that of the pallets on the upper strand.

On these new machines, sliding friction between the pallets and the wind box tops is eliminated by carrying the weight of the loaded pallets on wheels running on rails. The pallet wheels are fitted with renewable steel bushings and have large oil receptacles. The sprocket

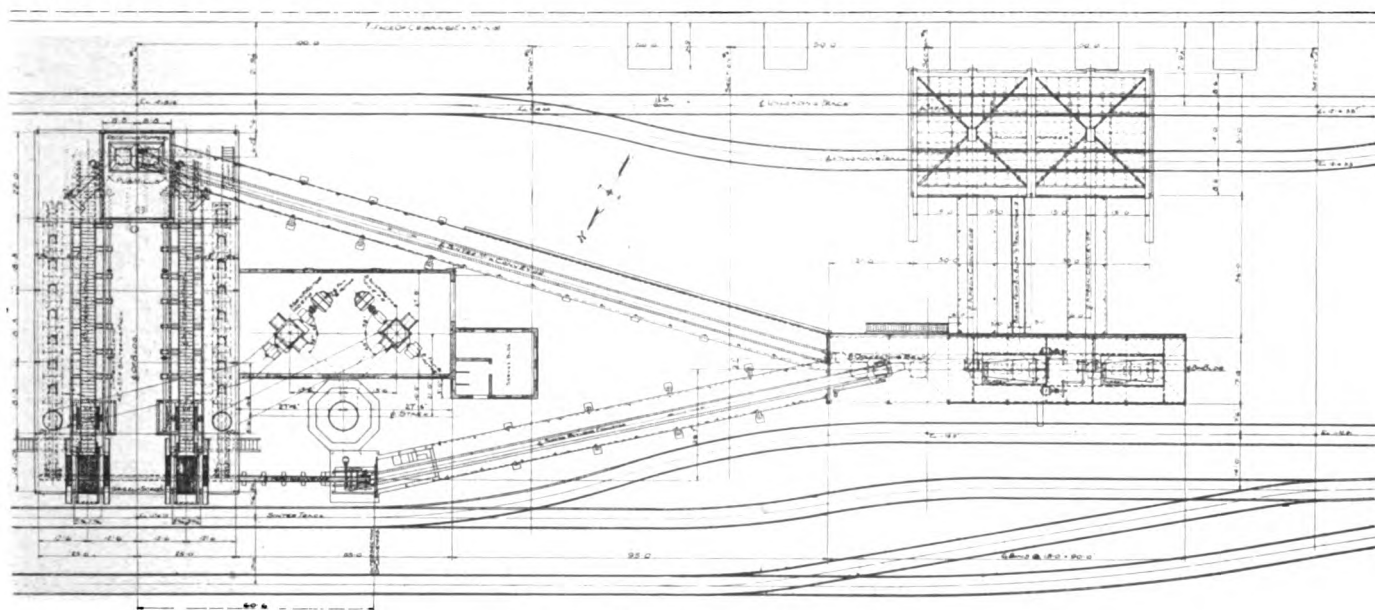


Fig. 3—General plan of the plant.

The success of the sintering process depends to a considerable extent on the quality of the mixture as it comes to the hearth of the sintering machine. This factor was given careful attention in designing the plant and as a result the pug mill and sintering machine in each unit are arranged in direct sequence. This insures immediate supervision of the material which is being fed to the hearth of the machine and enables prompt regulation of the content of the mixture in the pug mill.

To maintain a uniform layer of material on the hearth, a swinging spout was constructed to feed the sinter mixture from the pug mill. The spout is pivoted at the discharge chute of the pug mill and by means of a rope and counterweight attached to a crank on a counter-shaft of the sintering machine, it is swung back and forth at right angles to the direction of the travel of the machine. In this way even distribution of the sinter mixture on the moving hearth is assured.

The sintering machines without any auxiliaries were furnished by the American Ore Reclamation Company, Chicago. They consist of endless trains of pallets or

wheel teeth drive against tooth surfaces cast in the frame of the pallet and against the pallet wheels. This allows the pallet wheels to properly perform their rolling function around the curved tracks at the drive end.

All of the gears and the sprocket wheel teeth on the machine are made of steel castings. All gears and the shaft couplings are wholly enclosed in heavy sheet steel guards. The sprocket wheel teeth are removable and are machined in jigs so that they are interchangeable and when worn may be replaced without tearing down the larger members of the drive.

An important feature of the new machine is the use of seal bars on the pallets, which automatically maintain air-tight joints between the pallets and the tops of the wind boxes. These seal bars are made very light and by their own weight bear on the finished surfaces of the wind box tops, and also fit against the finished sides of the pallet slots in which the bars are hung.

As the pallets travel under the swinging spot, they receive a layer of sinter mixture. The depth of this layer

is a variable one, depending on the fineness or coarseness of the mixture. There is always some critical thickness for any specific mixture at which the greatest quantity and the best quality of sinter is produced. With any arrangement of bins and feeders the thickness of the sinter mixture layer varies considerably from day to day.

According to the principles involved in making sinter under the Dwight & Lloyd patent, there is sufficient carbon in the sinter mixture to support combustion, provided the necessary ignition and oxygen are supplied. Flue dust from its very nature is a homogeneous mixture of fine ore and coke and at this plant the flue dust contains enough coke so that it is not necessary to add any further carbon to the mixture.

The ignition burner, which was built by Arthur G. McKee & Company, is 2x4 ft. overall and is suspended directly over the pallets. Gas for ignition is taken from the top of a 24-in. main that runs through the plant and supplies the Cambria Works from the Cambria Steel Company's new Rosedale plant. By taking off the top of the main a very clean gas is obtained so that practically no trouble is experienced from an accumulation of tar. The necessary air is supplied by Roots positive pressure blowers. These blowers are motor driven and are located on the ground floor. The flame must be of sufficient intensity to positively ignite the entire surface of the charge without completely drying it. If the mixture is prematurely dried, the sintering action is retarded. The pallets travel at a speed of from 30 to 90 inches a minute while combustion is going on. Finally when the combustion is completed, the pallets arrive at the end of the machine where they are dumped by dropping one pallet at a time down a curved track. Each pallet hits the one ahead of it a blow that throws the material against an inclined grizzly screen.

A suction of about 20 inches of water is maintained by means of a fan for each machine which is directly connected to a 350-hp motor. The fans have 100-in. impellers; they revolve at from 600 to 720 rpm and have a capacity of 30,000 to 60,000 cu. ft. of gases per minute each. The fan is enclosed in a steel casing and the bearings are water cooled. The fans were manufactured by the Buffalo Forge Company, Buffalo, N. Y. The fans are located in a separate brick building 27x54 ft. Underground flues lead the gases to a single stack 90 in. in diameter by 80 ft. high.

As the sinter leaves the machine it is dumped on a grizzly screen 5 ft. wide by 12 ft. long, set at an angle of 32 degrees with the horizontal. The bars of the screen are spaced to give a clear opening on $\frac{3}{4}$ inch. The finished sinter passes over the screen and falls into railroad cars.

The openings in the grizzly screen are designed to give between 20 and 30 percent screenings. These screenings are called "returns." It is desirable to have this large amount of returns since when mixed with the raw flue dust we not only get better sintering action, but also decrease grate bar breakage.

It has been the custom in the past to handle the returns in railroad cars, placing a depressed track under the sinter screen. With the large percentage of returns this not only requires a number of cars in this service constantly, but requires expensive shifting and unloading. This has been eliminated in this plant and the returns are returned into the system by means of conveyors.

As the returns drop through the grizzly screen they are caught by a hopper that will hold about 25 tons. This hopper is provided with a gate that feeds onto a cast iron pan conveyor. The returns at times are red hot and must be cooled with water. This puts a severe condition onto the conveyor. The conveyor itself consists of two strands of extra heavy bushed roller chain between which are hung cast iron overlapping pans. All articulation points of the chain are either chilled iron or case hardened steel. The conveyor is driven by a 7½-hp motor through spur gear reductions. The gearing is protected with heavy plate guards. This conveyor extends beyond the building about 30 feet without a covering, giving the hot material a chance to cool before being discharged onto an inclined belt conveyor which elevates the material into either of two storage bins. These two bins having a capacity of 160 tons each, are at the same level and in line with the four stock bins above mentioned. They are provided with feeders and discharge onto the same belt that receives materials from the other stock bins.

Under each sintering machine there is a dust settling chamber through which the hot gases pass before entering the fans. These are steel bills each approximately 5x10x60 ft. and provided with seven cleaning doors each.

Views shown on Page 636 are descriptive of the following:

- No. 1—Complete plant view showing discharge and sintering plant and bin building at the right.**
 - No. 2—Operating floor showing super-hopper, pug mills, feeders, ignition burners and Dwight & Lloyd sintering machines.**
 - No. 3—Sintering machine return track and machine drive.**
 - No. 4—Ground floor showing wind boxes and dust collecting belt.**
 - No. 5—Raw material feeders in bin building.**
 - No. 6—Raw material unloading station showing cars discharging flue dust into track hoppers.**
 - No. 7—Suction fan showing switchboard in back-ground.**
 - No. 8—View of truncated raw material revolving screen.**
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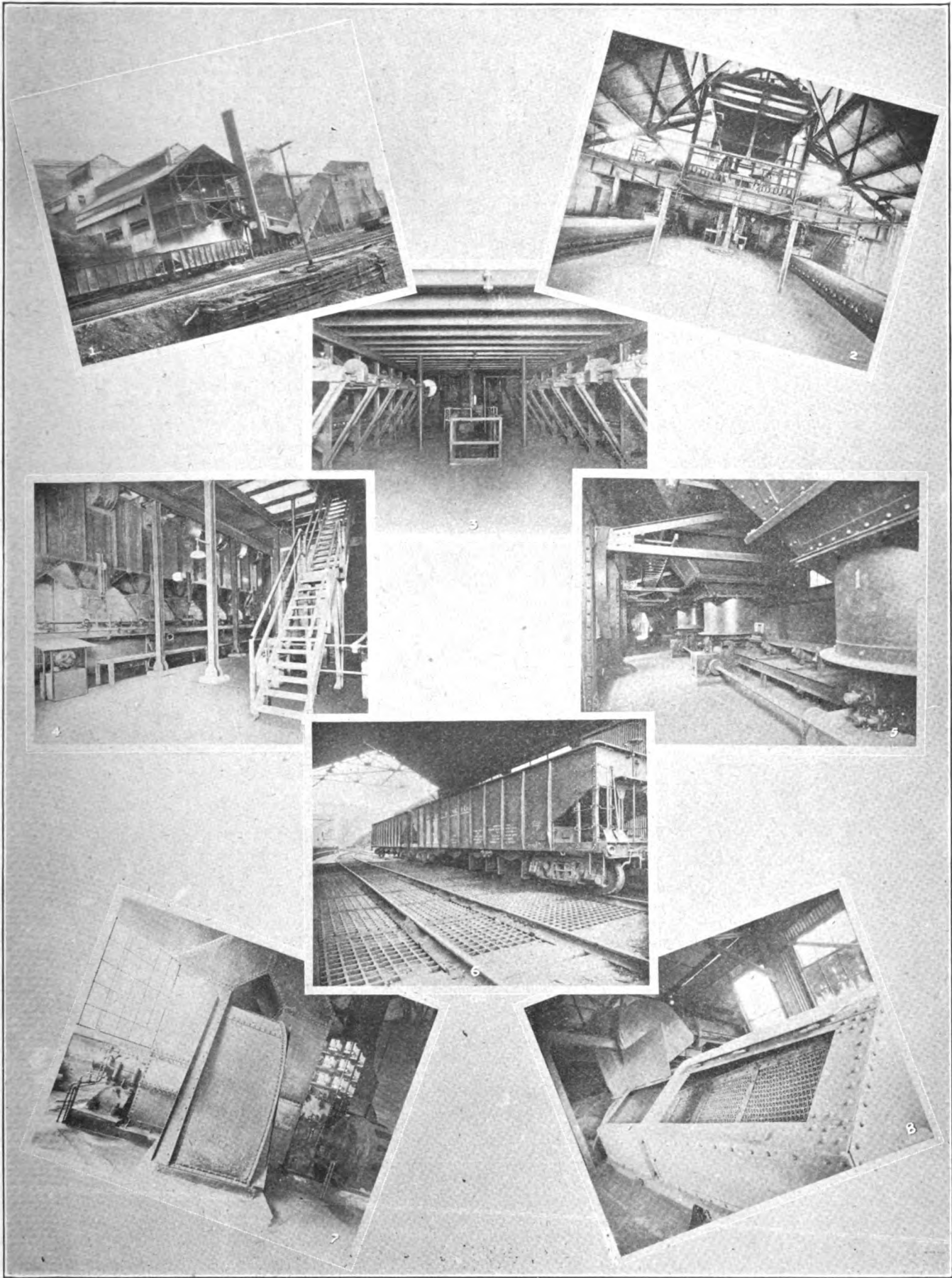
These bins must be cleaned every 24 hours. It has been the custom in previous sintering plants to open the doors and drop the accumulated material on the floor and then have the material cleaned away with wheel barrows. The hand handling has been eliminated in this plant by the use of a belt conveyor placed under each dust chamber. These belt conveyors discharge into the cast iron pan conveyor above mentioned. The material is mixed with the returns in the return bins.

The motor equipment was supplied by the Westinghouse Electric & Manufacturing Company.

Adhering to the general policy of the Cambria Steel Company, the entire plant was designed to make it an absolutely safe plant for the workmen. All gearing, shafting, belting and all moving parts are enclosed and all platforms, etc., are provided with hand railing and toe boards. All floors and platforms are of concrete to allow for flushing out the entire plant with a hose.

The buildings are all substantial, being either heavy steel framing or brick. A brick office building and service station make the plant complete in itself.

All machinery is of heavy design to reduce wear and renewals to a minimum. By the correct choice of labor saving machinery and the utilization of centralized elec-



trical controls and interlocks, the working crew is reduced to 12 men.

The entire plant, with the exception of the electric wiring, was designed and built by Arthur G. McKee & Company, Cleveland, the erection work being under the direction of Mr. H. B. Pearson, Jr., general superin-

tendent.

The interests of the Cambria Steel Company were looked after by Mr. W. C. Frank, assistant chief engineer, and Mr. H. C. Proudfoot, electrical engineer, under the direction of Mr. H. A. Berg, assistant general superintendent.

Comparison of Beehive and By-Product Coke

Many Advantages of By-Product Coke Over Beehive Coke Are Given—By-Product Coke Has Greater Strength, Is More Uniform in Size and Contains Less Small Coke and Breeze.

BEFORE entering into a comparison of beehive and by-product coke, the general characteristics which govern the fuel value of coke in general will be briefly discussed. As practically all beehive coke is used for metallurgical fuel, the domestic coke field will be omitted entirely. The principal metallurgical uses are in the foundry cupola and the iron blast furnace, so their requirements will be used as a basis for discussion. Other metallurgical processes, such as lead and copper smelting, etc., are in many respects very similar in their requirements to the iron blast furnace.

The governing qualities of a good metallurgical coke are proper physical structure, size and analysis.

For best results as metallurgical fuel, it is essential that the coke be of free burning structure. This applies both to foundry and blast furnace coke. Free burning qualities are controlled by the cell structure, which includes porosity, or percentage of cell space in the coke, and the physical condition of the carbon composing the cell walls. In general an open, porous coke, whether the cells are small or large, is free burning. A dense, finely porous coke is generally slower burning. When in either case the cell walls are heavy and solid or the carbon is in a more or less dense and refractory form, or both conditions are present, the coke is rendered less combustible or slower burning. The cell space, or porosity, governs the surface exposed to the attack of oxygen, while the cell wall structure and condition of the carbon controls the rapidity of oxidation or combustion of the carbon when attacked. So-called hardness is believed to be dependent on these same physical characteristics and the hardness test is a method for empirically gauging the combustibility.

The proper size of coke depends largely upon the nature of its treatment before using and the conditions under which it is burned. In foundry practice the coke receives very rough treatment at the consumer's plant, being forked and thrown at least three times and often more before coming to rest in the cupola. Then the heavy scrap and pig iron is thrown in onto the coke with a drop anywhere up to 15 feet, or even more in large cupolas. As any coke is essentially brittle and friable to some extent, it is necessary that it should start out at rather fair dimensions in the car, as received, in order to reach its destination in the cupola with a reasonable final size. Blast furnace plants handle the coke much more carefully before charging and it receives less severe treatment during charging and in the furnace. Hence the

size as received is fairly well maintained and a smaller initial average size is permissible.

In the foundry cupola and blast furnace the coke acts not only as a fuel, but also as a medium for maintaining proper openness and the distribution of material in the whole stock column. The charge in a cupola is very open, due to the nature of the materials dumped in. Therefore, the coke maintains the distribution of the pieces of pig iron and scrap and insures their proper heating from all sides. As the column is open only a low wind pressure of a few ounces is allowed for. Thus any tendency toward small coke and a dense, tightly packed stock column, either throughout or locally, is immediately followed by improper penetration of air blast and channeling. In the blast furnace the ore materials are generally fine and earthy. As the whole column is fairly dense a strong air blast pressure of 15 to 20 lbs. is maintained. The coke here acts to open up the stock column and allow proper distribution of the rising gases. If of uniform size the coke can be quite small; but any tendency toward an appreciable percentage of pea and breeze sizes has very bad effects on furnace practice. If on the other hand the size is too large, the rising gases pass out too freely with channeling, which results in insufficient exchange of heat and chemical reaction with the ore. Large foundry coke is not good blast furnace fuel, especially for smaller blast furnaces, for this reason. Roughly it may be said that an average size of about two fists together is right for good foundry coke, while an average size of one fist is right for blast furnace coke. Both must be free from fines.

The combustibility and size of the coke depends both upon the coal or coals used and the method of carbonization. Analysis, however, depends entirely upon the coal charged. All other things being equal, there is no doubt but that the lower sulphur and lower ash coke is preferable. However, coke structure and cost must also be considered. A high sulphur, high ash coke with good free burning characteristics and of proper size is much superior in the blast furnace to a low sulphur, low ash coke which does not burn freely or that is too small or too large. This is true to a somewhat less extent in the foundry cupola, if proper attention is given to slagging off the impurities. The melting action in the cupola, and the comparatively small volume of slag normally allowed for, entails a strong tendency for the sulphur in the coke to enter the iron. Hence, in general, foundry coke should not run over 1.00 per cent sulphur and 12.0 per cent ash. In the blast furnace, however, the high temperature and

large volume of slag allows of the fluxing off of large amounts of sulphur if a hot hearth and proper slag conditions are maintained. These conditions are dependent upon a very free burning coke of proper size. Such a coke may carry up to and even over 1.5 per cent sulphur and 150 per cent ash and show excellent furnace practice with high quality, low sulphur pig iron production. On the other hand a slow burning coke running less than 1 per cent sulphur and 12 per cent ash will show poor furnace practice, with hot top temperature and cold hearth, producing off grade high sulphur iron. Analysis and cost, therefore, do not determine proper foundry and blast furnace mine true coke value.

In comparing by-product and beehive coke it is necessary to allow for the different conditions of carbonization. The beehive oven is charged with a layer of coal about 24 to 27 inches deep, depending on whether the charge is for furnace or foundry coke. The bed of coal is not compressed at all and is absolutely free to expand vertically during coking. The coking temperature is low—about 800 to 900 deg. C.—and the coking time 48 hours for furnace coke and 72 hours for foundry coke. Heat for coking is generated by the partial combustion of the evolved gases and some of the coke itself, due to the admission of air through a suitable hole in the bricked-up door. Coking is practically entirely from above and finally penetrates the whole depth of the charge. The final coked bed will run from 26 to 30 inches in depth. Beehive coke is, therefore, columnar or fingery in form and of a length up to the depth of the coke bed. Due to the long, slow travel of the final distillation gases from the bottom of the charge through the hot coke, partial decomposition, or cracking, takes place, resulting in a deposited layer or "skin" of silvery carbon. This gives the coke a decidedly pleasing, bright, metallic and clean appearance. As the whole bed is perfectly free to expand during the plastic stage of coking, the coke is generally quite light and porous. The low coking temperature and other conditions results in the carbon in the cell walls being in a very combustible form. Beehive coke is, therefore, usually free burning. Owing to their fingery or columnar form, the coke pieces tend to mesh together in parallel upon agitation or shaking down. The presence of the smooth carbon skin aids in this packing tendency. As a result of an apparently large sized beehive coke will give a comparatively compact stock column in the furnace or cupola.

By-product coke is made in narrow chambers or ovens about 10 ft. high, 37 ft. long and 15 to 20 in. in width. The coal is charged into the top and fills the oven, allowing only sufficient space above for the evolved gases to pass off. All heating is accomplished by burning gas in flues in the oven walls. No air at all is admitted to the oven chamber during carbonization of the charge. The coking temperature is normally about 1000 deg. C. and coking time at least 1 in. per hour total, or 15 to 20 hours, depending upon oven width. This is often exceeded materially by carrying higher temperatures. As the coal is coked in horizontally from both sides, there is always a line of cleavage at the center of the oven. Thus the coke from an oven of 17-inch average width can be only 8.5 inches long or one-third the length of beehive coke. The coke is, therefore, more blocky and chunky in form. The charge being confined between walls during carbonization, there is less freedom for expansion during the plastic stage and hence a stronger, more compact coke, which still maintains the necessary porosity and free burning characteristics, is produced. Where the width of ovens is properly proportion to the coal being coked, the tem-

peratures are such that the cell walls are thin and composed of carbon in the most free burning form. As the gases are evolved rapidly and pass through only a thin layer of coke, even at the end of the coking period there is not the cracking and deposition of carbon as found in the beehive oven. Therefore, by-product coke is porous clear to the surface and is generally dull and lusterless. Under certain conditions a very small deposit of carbon, in sooty form, is produced, which gives the coke a very dark, irregularly shaded surface. This general appearance has no connection at all with the combustibility and analysis of the coke itself. The absence of carbon skin makes the coke surface rather rough and slightly jagged. This, in conjunction with the chunky, block form of the by-product coke, prevents its packing down as closely as beehive coke. For this reason the comparatively small sized by-product coke will give just as open a blast furnace stock column as the larger sized beehive coke. The ranges of sizes not being nearly as great, the more uniform sized by-product coke gives a better and more regular stock and gas distribution in the furnace.

It is, of course, well known that the beehive ovens can make coke from only the best coking coals and that no mixing of coals can be economically provided for. Each beehive plant is located at, and receives its coal from, a certain mine or group of mines. As the production of coal from one mine, or group of mines, is not sufficient to supply coke for a large blast furnace plant, it becomes necessary to use coke from several different beehive oven plants, with consequent variation in quality. No matter how carefully shipments are apportioned, the fuel from day to day will vary as coke is received from the different shipping plants. Although the average quality of the cokes may be excellent, the variation in their individual characteristics will show up in a tendency toward irregular furnace practice.

By-product ovens are usually located at or near the blast furnace plant and can coke a wide range of coals, entirely out of the question for beehive ovens. By maintaining a constant coal mixture, uniform coke is produced and blast furnace practice can be adjusted to regularly use this coke to best advantage. The cost of the by-product coke and its quality are, therefore, much more under control than is the case with a beehive coke supply.

In conclusion it may be said that by-product coke has combustibility equal to or greater than that of beehive coke. It has greater strength, is more uniform in size and contains less small coke and breeze. The analysis is strictly controllable, as coals of satisfactory chemical quality can be mixed. In addition there is the advantage of a uniform coke of any desired structure, size and analysis produced from the by-product coke plant as compared to beehive coke from several different plants.

INDIA TO INCREASE STEEL PRODUCTION.

India, during the next five years, will witness considerable development and growth in its metallurgical industries, particularly those of iron and steel, in the opinion of Mr. S. M. Marshall, consulting engineer for the Tata Iron & Steel Co.

At the present time there are only three industries of this kind in operation. There are three large new plants under construction or in serious contemplation. These are the Indian Iron & Steel Co. near Asansol, the Eastern Iron Co., whose plant will probably be located near Chandil on the Bengal-Nagpur line from Sini to Adra, and a third company whose plant will probably be at Manharpur.

Modern Method of Steel Billet Grinding

Advantages of Grinding Over Chipping in Relation to Wheel Cost, Labor Cost and Overhead—Grinding Wheels Remove Seams Cleaner Than Chipping Chisels

By R. H. CANNON*

WHEN molten steel is poured into an ingot mold, there are almost always a few flaws in the ingot after it has cooled. Some grades of steel are more troublesome than others in this respect, but in spite of the greatest care in pouring and cooling it seems to be next to impossible to produce a perfect ingot. There will be checking, blow holes, slivers caused by splashes on the side of the mold, slag inclusions, piping, etc. Some of the blow holes become oxidized as do cooling checks and slivers and these defects cause seams in the steel which cannot be welded together by reheating and working. Unless removed by mechanical means they will persist down to the finished product.

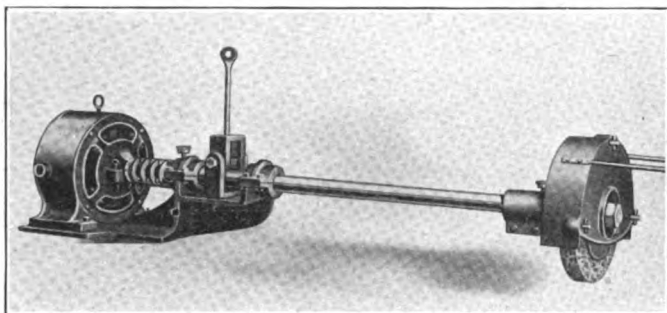


Fig. 1—A substantial type of motor driven swing frame grinding machine.

Seams are usually removed when the steel is in the form of a billet and there are two methods of accomplishing it: by the pneumatic chisel or by the grinding wheel. The softer steels can be handled to good advantage by a chisel, but for the harder ones it is necessary to use a grinding wheel. It will cut high carbon and high speed steel more efficiently than any other tool.

A grinding room or "cleaning room" as it is sometimes called should be equipped with a number of swing frame machines. This type of machine is the only practical one for handling billets. While all swing frame machines may appear to be of the same general type to the casual observer, to those who have seen a large number of billet grinding rooms there are certain very important differences. Let us point out certain features which should be insisted upon when this part of the equipment is being selected.

The pulleys and belts should be large enough so that there will be a minimum of slippage. Especially on the vertical belt with a rather small pulley at the bottom there is likely to be a great loss of power when too heavy pressure is being exerted between the wheel

and the work. To do away with this difficulty pulleys and belts should be generous in width, depending of course on the diameter and width of the grinding wheel. The pulleys should be large enough in diameter. The most common type of swing frame machine is run from a countershaft and is suspended from the ceiling as shown in figure 1. The weight of the wheel head is taken care of by a counterweight. Another type is suspended by a vertical bar from a trolley overhead while the power is furnished by an individual motor on the end of the horizontal shaft. Thus the motor balances the wheel head. The wheel runs sometimes perpendicular and sometimes by the use of beveled gears parallel to the horizontal shaft. In either case positive power is insured. It will be found, however, that excessive vibration occurs when wheel head and motor are so delicately balanced in this way, whereas the counterweight held by a cord passing through two pulleys on the ceiling absorbs a great deal of the vibration. Therefore the more common or counterweighted type is preferable.

Most swing frame machines have the wheel mounted between the spindle bearings, while one or two manufacturers have the wheel on the end of the spindle. The latter method presents some difficulty in the question of balance but this can be overcome and a great many concerns are now using machines of this type. Quite a few of them are of their own design. The advantages of having the wheel "overhung" or mounted on the end of the spindle are obvious at once. If the machine has to be taken apart and the bearings removed to take out the old stub and mount a new wheel an average of at least 20 minutes is consumed. On the other hand a new wheel can be mounted on the end of the spindle in approximately three minutes. When it is necessary to take the boxes apart, it is a difficult task to adjust them without having them too tight or too loose. The painstaking job of adjusting shims is necessary, and after it is all done a certain amount of dirt and abrasive is bound to have gotten into the boxes, causing excessive and unnecessary wear.

Billets usually come to the grinding room directly after cogging or rolling. An ideal arrangement is to bring the billets in on a lift truck leaving a loaded body on one side of the inspection table and an empty body on the other. A group of about six grinders will handle that particular load. As each grinder finishes his billet he places it on the inspection table, and the inspector either passes it on to the empty truck body or returns it beside the grinder's bench to be touched up. This system involves a minimum of handling and insures careful inspecting. In some mills the inspecting is done before grinding and a chalk mark placed around each seam. The grinder then confines his at-

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tention only to the spaces within these circles. A better practice is to instruct the grinder to remove every seam. He "skins" the billet all over, that is, he removes every bit of scale and can then see each seam plainly. Some concerns "pickle" the billets in acid to remove the scale, but the practice of removing it by the wheel takes only a moment and shows up the seams better than by any other method. Grinding should be done across the seams, not only because this method is most convenient but because the seams are then plainly visible. If ground longitudinally the grain marks will tend to obscure the seams.

ing, and determine the number of pounds of material removed by each wheel.

In determining the cost of grinding it will be found most convenient to divide it into three divisions, wheel cost, labor cost and overhead. The most accurate way to get at wheel cost is first to observe the average diameter at which stubs are discarded. The difference between the volume of the full sized wheel and the volume of this stub gives the volume of useful abrasive. This has cost the price of a full sized wheel. Dividing the cost of the wheel by the volume of useful abrasive gives the cost of one cubic inch. A test

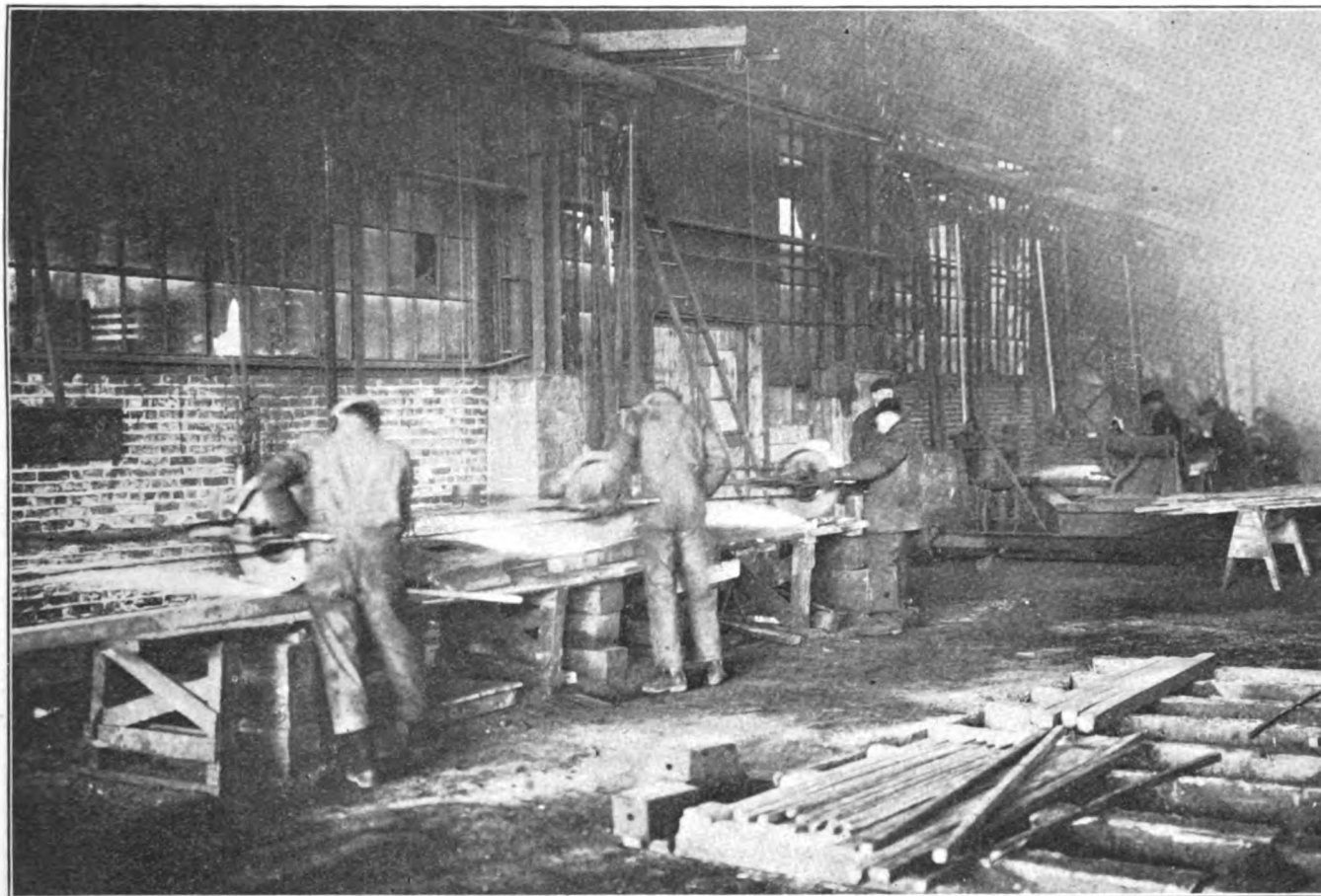


Fig. 2—A billet grinding room.

It is impossible to name a grain and grade of grinding wheel which will always give the most satisfactory and most economical results. A good average wheel for high speed billets is Norton grain 20 grade R Alundum vitrified and for high carbon steel grain 14 grade S Alundum vitrified. Exactly the right grain and grade and the right make of wheel for a particular set of conditions can be determined only after careful test.

Conducting a grinding wheel test involves careful record keeping and in order to be accurate it should be run for some time so that a fair average can be credited to each wheel tested. This is to allow for differences in pressure exerted by different operators and different weights of machines, or in other words to allow for the variable effect of the personal factor. It would perhaps suffice to measure the efficiency of the wheels by counting the number of tons of billets produced. It is possible to do this but a more accurate method is to weigh the billets before and after grind-

wheel can now be removed at any time and actual wheel cost computed by multiplying actual wheel wear by the cost per cubic inch.

It is best to remove the wheels at nearly the same diameter if possible. A wheel wears much faster as the size is decreased either because of lower peripheral speed or if the rpm be increased, because each particle is coming into contact with the work more often so that it is dulled and torn from the bond in a shorter time.

Labor cost can be figured by piece rate or by the hour.

Overhead is reckoned in many shops as so many times labor cost or so much per unit of production. For the present purpose it must be extracted from the Cost Department's records as so much per machine per hour so that it can be reckoned for the life of each wheel. This method also makes overhead a constant figure, that is, independent of the rate of production

of the wheel when the workman is paid by piece rate. The overhead per machine per hour is sometimes hard to arrive at but is just as important as the other two terms of cost. What is desired is the total investment incurred by the grinding room (including supervision expense) and the number of pounds of steel removed by the wheels of each grain and grade. From these figures we can determine the cost of removing one pound of material. The wheel which removes material at the smallest cost per unit is, of course, the most economical wheel.

Let us see why it is necessary to take into account all these factors. Each department looks at the problem from a different angle. To the purchasing agent usually the most economical wheel is the one which lasts the longest. To the grinding foreman and the operator the best wheel is the one which cuts the fastest. To the Cost Department and the efficiency engineer the best wheel is the one which turns out a unit of production at the lowest cost, all items of cost being considered.

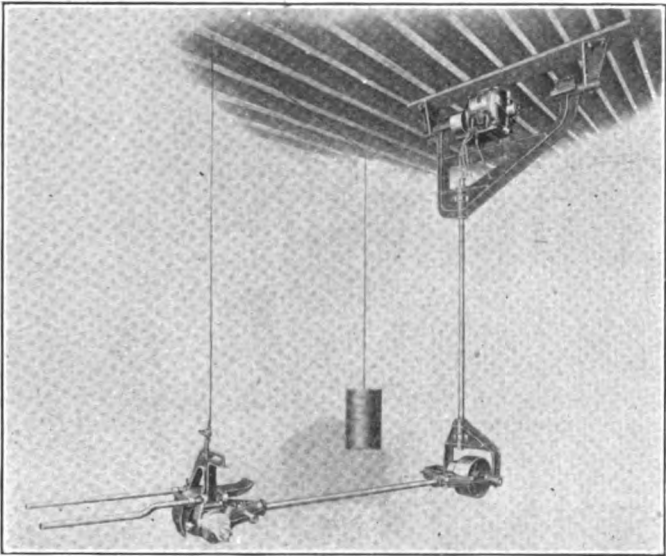


Fig. 3—A new swing frame grinder mounting the wheel on the end of the spindle instead of between the bearings. (Manufactured by the Safety Emery Wheel Company, Springfield, Ohio.)

There are a number of items to keep track of and the data sheet illustrated in Table A is suggested for this purpose. These figures are then transferred to a general data sheet Table B and results computed to show the cost per unit ground. This figure is then averaged for the wheels of each grain and grade. Objections are often offered to keeping so much data but it is really not much work. If the workmen are intelligent enough to weigh accurately each man can keep his own data sheet as shown in Table A. If they cannot be depended on the inspector can do it. The rest of the computation is not as complex as it may look.

In the example given it will be noted that with the wheel which lasted 36 hours and removed 72 pounds of steel the cost per pound of steel removed is \$.49. This wheel is too hard and too slow cutting to be economical. The next wheel lasting 6½ hours removed only 22½ pounds of material and the cost per pound was \$.49. This wheel was so soft that the particles did not remain in the bond long enough to cut efficiently. Wheel cost was excessive with not enough gain in speed of cutting to make it economical. The third wheel, while only of medium life cut at a very fast rate and removed material at a cost of only \$.27 per pound. The saving in a year from finding a wheel which will perform in this way is worth many times the trouble of running the test.

Many foremen argue that all they want to know is how long a wheel lasts and how much it produces. That is not the whole story. What is required is the return which the grinding room is making on the money being invested in it. If the wheel is too hard it cuts slowly and, although the wheel cost is low, the labor and overhead expense are going on just the same and money is being lost. Furthermore if the wheel is too hard it will heat the work to such an extent that the seams, instead of being ground out are driven further into the billet. If the wheel is too soft the wheel cost is excessive even though production per unit of time is greatly increased. The problem is to find by experiment the wheel which gives the highest return on all items of investment.

There is another problem which to the writer's knowledge has not yet been solved. It is to determine the point at which it is more economical to give up chipping and remove the seams by grinding. It is generally believed that steels of more than 60 per cent carbon and all steels containing tungsten, chromium and manganese can be more economically ground. The problem could first be worked out with plain carbon steel and then with the alloys. It would take a great deal of experimenting, but would be very valuable knowledge. In arriving at a conclusion it should be remembered that the grinding wheel removes seams cleaner than does the chisel. The chisel tends topeen the seam over so that the workman is not sure he has gotten to the bottom of it. In the grinding method the seam is plainly visible until entirely ground out.

TABLE A.

Machine No.			
Wheel			
Size			
Time Mounted			
Time Removed			
Hours Run			
Diam. When Removed			
Wheel Wear			
Weight of Billet before Grinding	Weight of Billet After Grinding	Material Removed	

TABLE B.

Wheel	Life in Hours	Diam. when Removed	Wheel Wear	Net Prod.	Material Removed	Cost	Labor	Overhead	Total	Cost per 1 lb. mat'l Removed
1	36	11½"	194	3,021 lbs.	72 lbs.	\$4.42	\$12.60	\$18.00	\$35.02	.49
2	6½	10	245	789 lbs.	22½ lbs.	5 58	2.27	3.25	11.10	.49
3	14½	11¼	203	1,825 lbs.	62½ lbs.	4.63	5.08	7.25	16.96	.27

Volume of Useful Abrasive—314 cu. in.

Overhead = \$.50 per hour per machine.

Net price of wheel = \$7.16 (16 x 2").

The Logic of Roll Design

General Discussion Pertaining to the Design of Rolls Employed in Mills Manufacturing High Carbon or Alloy Steels.

By W. H. MELANEY

PART VII

THE design of rolls for high carbon or alloy steels, such as high speed steels, is a matter of special interest as this differs in many respects from the methods employed in rolling low carbon steels, such as are produced by the ordinary merchant mill.

Roughing Rolls.

The same general type of roughing rolls are used for rolling high carbon steels as are used in the merchant mills with one exception. That is, that less reduction between passes is employed. This is due to two conditions: (1) The hardness of the steel due to its composition, and the lower heat at which most of it must be rolled, in-

In view of the conditions as stated above, a smaller billet is used on mills of this type than is used on ordinary merchant mills of the same diameter rolling soft steel.

Pony Roughing or Strands.

The same general type of roll is used for strands on hard steel as is used in rolling soft steel, however, the reduction from pass to pass is less. This is especially true on the reducing oval passes where if the reduction were as heavy as that used in rolling soft steels, the bar would not readily enter the pass and the end would become cold from the water used on the rolls. This would necessitate the cropping off of the end of the bar and as

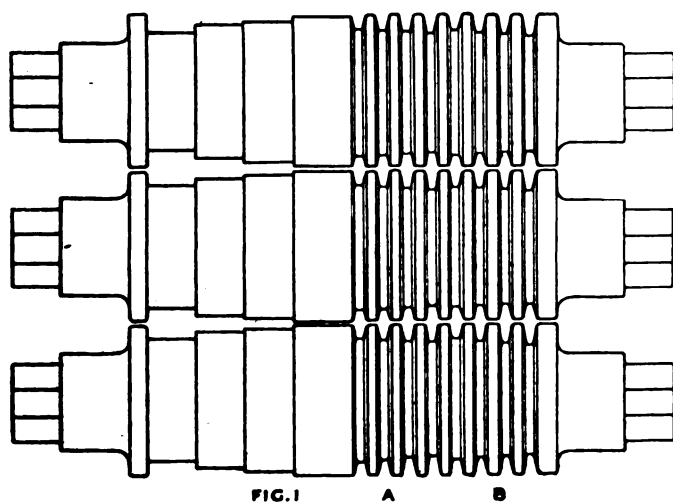


FIG. 1

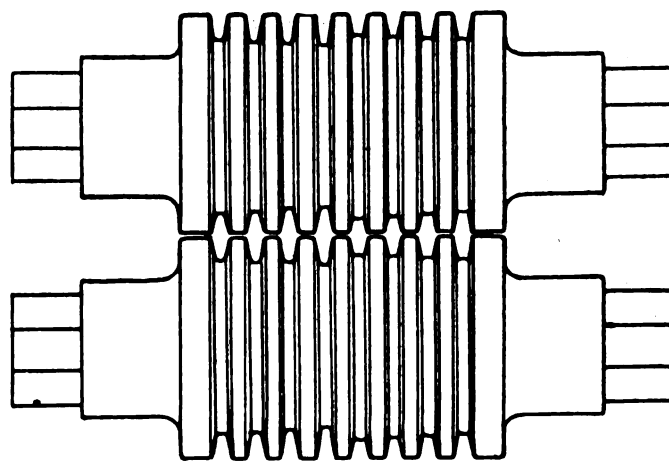


FIG. 2

creases its resistance to elongation, therefore the spread is greater; (2) Due to its hardness and the fact that ragging the rolls is not permissible. As a result, the bite of the rolls is decreased and the consequent retarding of the entrance of the bar into the rolls is greatly increased.

Logical solution to overcome both of these difficulties is to have less reduction per pass. There is also a decided preference by most rollers to use all open square grooves in the roughing roll instead of the usual box passes used in the beginning of most merchant mill roughing. The reason for this is that the pressure on an open square groove is always toward the center from all four sides of the bar, thus reducing the size of the grain of the steel. In the box groove, the pressure is only from two sides and does not permit the opening up of the grain from spread.

It is pertinent to again call your attention to the previously stated fact that ragging on rolls for high carbon steels is always deleterious. It should never be resorted to because the effect of the ragging will show up on the finished bar as a surface defect.

as a result many delays and a general loss of tonnage would take place.

Step and Edging Rolls.

From this point on, the design of rolls differs materially from those used in soft steel mills. Usually a set of three high step and edging rolls of chilled iron are used instead of the tongue and groove sand iron rolls, for rolling all sizes of flat steel. (See Fig. 1.)

On this type of rolls a square billet from the roughing or strand rolls is entered on one of the steps and is reduced on the successive steps to the required thickness necessary for entering the edging groove that will give the width of the bar to be produced. Either one or two edging passes are used to suit the prevailing conditions.

These edging grooves serve two purposes, to-wit, the standardizing of the width of the bar and due to the upsetting of the bar edgewise breaking off the scale from the sides of the bar and permitting a much smoother finish to be obtained after the bar has received a planishing pass through the chilled bull head rolls.

It will be observed that the bottom of the edging grooves are made of a shape to suit the edge of the bar desired either round or square edge. If a square edge is desired then the bottom of the edging groove is made convex as shown at A-Fig. 1, thus rolling the edge of the bar concave so that when the bar is subsequently

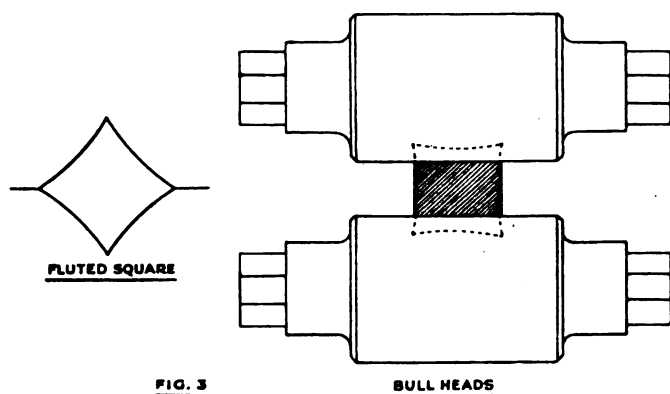


FIG. 3

BULL HEADS

planished through the bull heads the spread of the bar which on thin bars will be greatest in the center, will push out this concavity until the edge is square as intended.

It is necessary of course to have just the right amount of concavity to overcome the tendency of the bar to bulge or become rounded on its edge, due to subsequent reduction on the bull heads.

If a round edge flat is required, such as used on flat spring steel, then the edging groove is rounded at the bottom in the opposite direction as shown at B-Fig. 1 so that the edge of the bar will be convex, but as stated above, due to the bulging of the bar as the center of edge on subsequent reduction, the rounding of the edge in the groove must be less than that required on the finished bar. The sides of these edging grooves have considerable taper, usually 9 or 10 degrees, to permit of easy delivery of the bar and the necessary upsetting to crack off the scale from sides of bar.

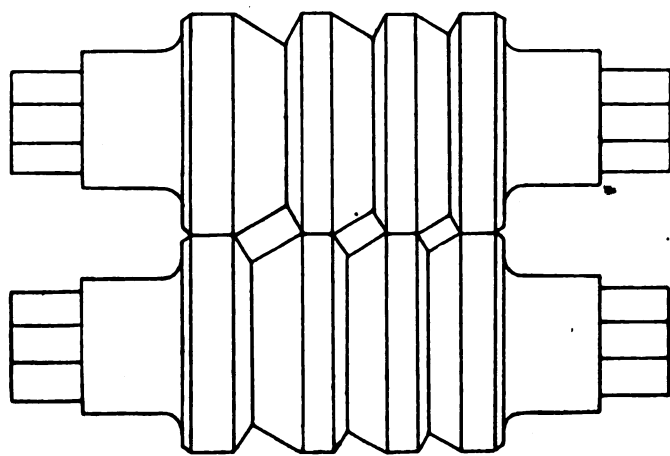


FIG. 4

After the bar comes from the edging grooves it is given one or two passes, depending on conditions, through plain chilled bull heads to reduce the bar to the actual thickness required.

On flat spring steel the last pair of rolls are turned to roll the bar slightly concave on top and bottom of the bar.

The advantage of the step and edging rolls is that a wide range of bars of different widths can be produced without the necessity of carrying a large stock of rolls as would be necessary if rolls of the tongue and groove type were employed, as the rolls can be raised or lowered within certain limits to produce a variety of widths.

Where absolute freedom of the edging rolls from interference with the step rolls is required a separate set of edging rolls are used in the stand that would contain the oval rolls in rolling rounds. (See Fig. 2) If rounds or squares are desired in high carbon steels they are rolled exactly the same as soft steels.

Thick Rectangular Bars.

In rolling thick rectangular bars with square edges where the thickness is but little less than the width of the bar two other methods may be used.

A given square is produced by the usual method except that all four sides are fluted or rolled concave as

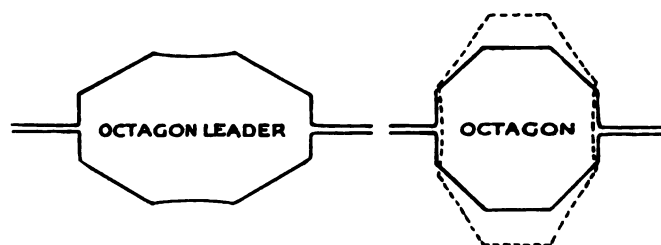
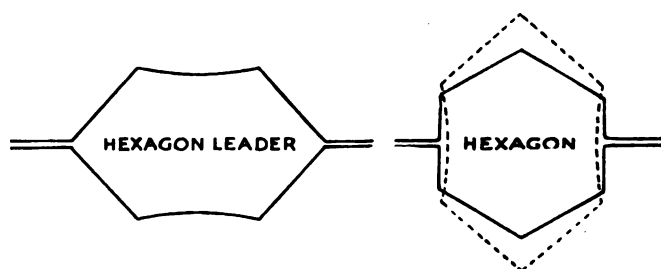


FIG. 5



shown at Fig. 3 and this is then flattened out on the chilled bull heads to the proper thickness of the bar desired, the fluted edges taking care of the bulge that would otherwise happen on the edges of the bar and producing a square edged flat bar.

Diagonal Flat Grooves.

The other method of producing a positive size of thick rectangular bar from a square is to turn the grooves into the rolls diagonally as shown at Fig. 4. These grooves simply acting as flattening grooves and preventing any bulge on the edges giving a square edged bar of positive size. And no tongue and groove is required to roll this type of flat; it is needless to mention that chilled rolls are always used for this work, thus giving a smooth finish to the bar.

Hexagon and Octagon Bars.

Hexagon and octagon bars are rolled on the same principle as a guide round, except that the shape of the grooves is radically different. In other words, a square billet from the strands is passed through a leader groove, as shown at Fig. 5, for either the hexagon or octagon as desired and then edged up into the finishing groove

to produce the shape wanted. The bar getting only one pass in the leader and one in the finishing groove.

You will note from the shape of these leader passes that four corners of either the hexagon or octagon are practically finished in the leader pass, the remaining corners in each case being finished in the finishing groove.

You will also note that the bottom of the leader grooves are made convex so that the bar will be rolled concave at this particular facet to allow for the bulge or spread when going through the finishing groove, as this particular facet will be opposite the break between the two rolls and if this were not done there would be a tendency to slightly overfill and cause the corners of the groove to mark this facet on the finished bar.

You will take particular notice that the finishing groove is divided in the rolls at the middle of one of its facets when it might just as well be divided at the cor-

ner between two facets, which is sometimes done, but the danger of getting a mark or overfill when divided at the corner is much greater than when divided at the middle of the facet, as all of the corners must be sharp and the groove perfectly filled.

There are no greater variety of shapes and sizes of bars rolled from high or alloy steel due to the numerous articles manufactured therefrom than are met with in mills devoted to rolling soft steel, and each one of them presents its own problems to the roll designer, but by applying the primary principles as outlined in this series of articles to the particular condition presented, little difficulty will be experienced in producing good results.

A great deal of high carbon and alloy steel is hand rolled, especially where absolute accuracy as to size and section is desired, therefore the tonnage of such mills is much less than that of the ordinary guide mill, rolling soft steel.

Low Temperature Carbonization and Its Relation to the Iron and Steel Industry

A Low Temperature Carbonization Will Only Prosper When Developed Along Similar Lines as the By-Product Coking Industry That Is Attached to Large Plants as a Supplementary Plant.

By A. THAU

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NEARLY 20 years have elapsed since Parker in England got first low-temperature carbonization protected by patents, as an initial effort to free the English cities, and in particular London, from the smoke and fog by removing from the coal used for domestic purposes its smoke producing constituents in subjecting it to low-temperature distillation. Compared with other industrial progresses, in particular with the closely related high temperature carbonization, the development in this special branch of the industry must be considered exceptionally slow. Though the facts upon which low-temperature carbonization is based had been recognized by way of research dating as far back as 1857, the practical application of the discoveries must be attributed to Parker who in 1915 took out a number of patents, for the exploitation of which the Coalite Company in London was formed which, after repeated failures and in spite of a very strong antagonism on the part of the English gas industry, is in England still in the foreground. Several other processes have since been exploited in the same country, but without an exception they have not been able to survive the trial stage.

In America as well as in Germany low-temperature carbonization had been taken up on a broad working scale just before the commencement of the war. The war gave fresh impetus to low-temperature carbonization in order to obtain as high a yield as possible from the coal, irrespective of the quality of the residue which at its best deserves its name, viz., "semi-coke." The two so far mentioned objects underlying low-temperature carbonization, viz., the production of a smokeless easily

ignited fuel and valuable oils, are supplemented by a third, viz., the economical utilization of a fuel rich in volatile matter which is not suitable for the production of metallurgical coke or as a steam or house coal. These three different directions dominate low-temperature carbonization respectively in the three countries named, in which it is mainly adopted. In England the production of a smokeless fuel stands in the foreground without, however, losing sight of the profits derived from the liquid hydrocarbons which the process yields so abundantly. In the United States the profitable carbonizing of certain classes of coal has been the main purpose to develop low-temperature carbonization to an accomplished process, while in Germany the recovery of the oils stands mainly and solely in the foreground. The unfavorable rate of exchange makes it very difficult to import mineral oils or gasoline into Germany on an extensive scale and thus the low-temperature carbonizing processes are destined to fill a serious gap.

In consequence of these different aims upon which the same process is based in each particular country can a very wide variation in the design and working methods be noticed. In England the intermittently working vertical retort, either made of cast iron or of refractory material, has been adopted by the Coalite Company. In America the continuously working horizontal retort in connection with a briquetting plant and inclined intermittently working high temperature retorts, both built of refractory material, have been given preference in the most successful plant, viz., the Carbocoal process. In Germany the continuously working revolving steel re-

tort has been almost universally introduced, probably on account of the fact that its design as applied to cement works and for roasting ores did not offer anything altogether new in the way of constructional details and obviated extensive experiments for which there was no time during the war. In comparing these three different methods by which the same process is explored, it becomes by the lack of uniformity apparent why the development has been so slow and why the iron and steel industry has been so reluctant in adopting low-temperature carbonization as one of its side lines like, for instance, by-product coke ovens or gas producers.

There is no doubt that the Coalite process in England is best adapted for its main aim, the production of smokeless fuel of lumpy nature. On the other hand does it become evident that the units of the Coalite plant are not designed for a large output of fuel. The retorts are small and if one considers that a battery of 20 retorts is required to deal with a daily quantity of only 60 tons of coal, there is no doubt that to deal with quantities nearing the consumption of even a middle sized industrial undertaking, a plant of great magnitude becomes necessary.

In Germany large quantities of fuel can be treated in a comparatively very small unit with continuously rotating retorts made of steel plates. The disadvantage in these processes, however, rests with the fact that while the coal is subjected to a very intense heating, without endangering the yield of liquid hydrocarbons by pyrogenic decomposing, the formation of coke is at the same time largely prevented and the residual product cannot easily be utilized.

The weak points of both these carbonizing plants have been overcome by the American Carbocoal process in which it is not attempted to make a suitable coke in one operation. The coal is first subjected to a continuously working low-temperature carbonizing process with the sole aim to obtain a high yield of liquid hydrocarbons, to pass large quantities of coal through comparatively small and automatically working units and the quality of the semi-coke is in the first place disregarded entirely. To convert it into a marketable product, it is afterwards briquetted with an addition of pitch and again carbonized so that the briquettes differ from all others in that they do not consist of a mixture of carbon and pitch, but have a quite homogenous texture.

The fact that the statements and promises put forward by low-temperature carbonizing undertakings have had a rather sceptical reception in most quarters is in no small measure due to the unnecessary secrecy into which these processes have been enveloped and which has done more harm than is generally realized by their promoters. Great credit is due to the Carbocoal Company for having abandoned this harmful practice by giving their system of operation wide publicity and insight into the smallest details by throwing open the gates of their plants for the closest inspection to interested parties.

When low-temperature carbonization was first planned on a working scale in England, it was planned as an adjunct to domestic gasworks. It was intended to supply a rich gas, high in calorific value and great illuminating power to enrich cheaper gases which might be advantageously produced in the gasworks, such as water gas, etc. The sales of the semi-coke would cover the cost of the coal while the oils and ammonia would, together with the price obtained for the gas, pay for the plant and its upkeep, leaving at the same time a large margin

as profits. The proposition was sound enough from the start, but the scheme was doomed to failure from the beginning for the simple reason that the plants were erected on a large scale before the experimental stage of the process had been passed. Experimenting with plant on a manufacturing scale has rarely led to profitable results and in addition the English householders were very reluctant in using the friable semi-coke. They would rather put up with a few foggy days and stick to their coal. In consequence the large plants had to be pulled down again after hardly one year's working and this fact left such a deep impression upon the otherwise very progressive English gas industry that its engineers have given up for ever taking low-temperature carbonization seriously. All progress made since then, all the many lectures of educational value in this field, all efforts to convince the gas industry that developments have since been reached which would justify a renewed co-operation are promptly rebuked by the English gas industry, irrespective of the fact that low-temperature carbonization people have been able to win very prominent scientists and gas experts as powerful promoters for their aims and ideas, such as the late Prof. V. B. Lewis, Prof. Armstrong, Prof. Bone and others.

Since it is apparently not possible to overcome the deep rooted prejudice of the gas works, the Coalite Company has been compelled to direct its efforts towards the large iron and steel industry to seek an outlet for the coal gas and possibly for the coalite yielded as a residue. A plant has been erected at Barnsley in Yorkshire where the surplus power is converted into electric energy and the coalite gasified in producers. Though this represents the largest low-temperature carbonizing plant in England, its size hardly exceeds that of a fair sized experimental station and until quite recently it has served more or less for that purpose. Still one must admit that the most important experiments have found a satisfactory solution and the process can now well board upon industrial lines without fearing the former disastrous experience. The present juncture seemed to be favorable for the extension of low-temperature carbonization in England on account of the gasworks being at liberty to abandon the former parliamentary standard for the quality of the gas based upon its candle power and to substitute a certain calorific value which in some cases, particularly in the Sheffield steel district, is inferior to the former quality. A number of industrial undertakings in Sheffield using gas in their industrial plants objected very strongly to a reduction of the calorific value and threatened to enter into combination with a low-temperature carbonization process for the supply of their gas. Several extensive schemes are in contemplation to supply a certain part of the industry with the rich low-temperature gas at a moderate price, but for a long time nothing further has been heard of these proposals and their realization. There is no indication as yet that the iron and steel works in England have taken up low-temperature carbonization on their own account as a side line.

In Germany, low-temperature carbonization has, as already mentioned, supplemented the deficiency of lubricating oils and gasoline. The process had been taken up scientifically first just before the war and has since made great progress, particularly in the lignite and shale districts. In the coal fields its development is as yet not so pronounced since there is a conspicuous absence of cannel or other bituminous coals high in volatile matter, and what there is is readily swallowed by the extensive by-product coking or gas industry if it has not to be sup-

plied to the former enemies in accordance with the peace treaty. Thus only a comparatively small amount of ordinary gas coal is being treated by low-temperature carbonization in the plants of which are attached to iron and steel works. The retorts are heated by blast furnace or producer gas while the rich low-temperature gas is used in open hearth furnaces, in iron mixers or in roasting furnaces. Particularly for the heating of revolving furnaces preference is given to a low-temperature gas on account of the great heating value concentrated in a comparatively very small gas volume. By using such rich gases as a heating medium, the suspension of dust, which is very conspicuous in kilns heated with blast furnace or other lean gases is very much retarded owing to the small amounts of flue gases which are being formed. The semi-coke is of rather poor quality, very friable and containing a very high percentage of small dust. It is either used as a fuel for producers or utilized as powdered fuel, for which purpose it must be mixed with a certain proportion of bituminous coal. Owing to its low specific gravity it might make a good colloidal fuel if mixed with certain oils, but the writer is not aware that trials in this direction have so far been made. Besides the yields of oil, great attention is being paid to the recovery of ethylene, of which the contents in low-temperature gas are comparatively high compared with coke oven or domestic coal gas.

In America again low-temperature carbonization is established as an industry of its own. The carbocoal plant at South Clinchfield in West Virginia is the largest low-temperature carbonization plant in the world and differs from all others in that the coke residue, the carbocoal, can be readily utilized in the iron and steel industry so that the process is not solely dependent upon householders as fuel consumers. Figures have been published as to the efficiency of carbocoal when burnt under boilers, in locomotives and as fuel for water gas producers, all of which were distinctly favorable. The possibility of using carbocoal in industrial furnaces was propounded and it would be very interesting if further results in this direction were published. According to the tests which the writer was able to make with single pieces of carbocoal, there appears to be no reason why it could in many instances not take the place of metallurgical coke if its price can stand the comparison. I am, however, of the opinion that for an effective use in the blast furnace, the carbocoal briquettes ought to be of larger size, so as not to form too dense a burden and to give more free space and less resistance for the wind to travel. In a cupola the carbocoal briquettes in their present size and shape and with their high density and crushing strength ought to serve excellently.

It has already been mentioned that the carbocoal people can take credit for having removed the veil of secrecy from low-temperature carbonization as far as their process is concerned. To convince the professional sceptic they would further serve a good purpose if they could see their way clear to supplement their statements by publishing a heat balance sheet of the whole plant. To the outsider it must naturally appear that a double carbonizing of the coal must require an excessive amount of heat quite apart from the heat required for steam raising, generating of electric power and for the distilling of the tar. The figures so far published are not quite clear upon this most important point of heat economy and require to be supplemented.

Still it is no small achievement that by this process for the first time a readily marketable fuel is being pro-

duced and the economy of such a plant may perhaps be considerably increased if it could be attached to other works where surplus heat in the form of gas is available and where the rich low-temperature gas as well as the fuel may be advantageously consumed on the premises.

The writer has been intimately connected with low-temperature carbonization for many years and has followed up its development very closely and has come to the conclusion that low-temperature carbonization has not much chance to prosper as an isolated or independent industry of its own. It will, in the writer's opinion, prosper and develop on similar lines like the by-product coking industry, if attached as supplementary plants to other large works which interchange the gas and take up the fuel and which for this purpose must be closely interconnected with the low-temperature carbonization plant.

Such plants can supplement large works in many directions by supplying heat to their particular manufacturing processes such as iron, steel and other metal works, ceramic works, power plants, etc. The idea has often been advanced to stop the use of raw coal in open fires altogether and to use coke or a coal from which the valuable hydrocarbons have been removed by distillation, or to heat solely with gas. Suggestions of that kind are too broad altogether and even if possible to carry them though would require such enormous alterations to existing plants or methods that it is quite unreasonable to preach in earnest such radical changes. On the other hand it has been proven often enough, but is not sufficiently known, that a given amount of fuel, gasified completely, does not give the same efficiency on, for instance, a steam boiler as if this amount of fuel was fired direct. An improvement of the efficiency under these circumstances might, however, be reached if the coal is subjected to low-temperature carbonization, the semi-coke be gasified in producers and the low-temperature gas be mixed with producer gas which thereby gets somewhat enriched. The proposition is not new and is put into practice at the already mentioned Barnsley power plant by the English Coalite Company.

The efficiency of a plant as just described irrespective of the low-temperature coking system applied for generating electric power could be still raised considerably if the gas generated was used in gas engines and the least valuable part of the tar oils in Diesel engines. By supplementing the varying power demands during certain hours of high load by the Diesel engines a very favorable load factor could be maintained on the gas engines in average.

In conjunction with iron and steel works, where the requirements for heat and power are more even, an equally good efficiency can be obtained without having to use the tar oils on the spot. There is no doubt that the very slow development of low-temperature carbonization is due to the fact that it is difficult to dispose of the semi-coke, owing to its inferior condition, and upon the disposal of the residue the whole economy of the plant must necessarily depend. If the general industry can utilize this fuel to advantage, then the progress is assured, but, as already said, only if the plants form an adjunct to large works, thus obviating an extensive transport of the residue.

Another kind of low-temperature carbonization must be mentioned in this connection which was largely introduced into Germany during the war and greatly assisted in relieving the acute scarcity of mineral oils for lubri-

cating purposes. Instead of passing the coal first through a low-temperature carbonizing plant and transferring the remaining semi-coke to gas producers afterwards, the same effect is obtained in one operation with greater economy. In the producer are—depending upon its diameter—suspended from above one or several vertical iron retorts which reach with their lower end close to the fuel bed inside the producer. The coal is fed through these retorts continually and by the hot producer gas surrounding the retorts and partly traveling upwards though the coal, low-temperature distilling is effected. The gases escaping on top of the feeder retorts are conducted through separate plant, freed from the oils which are carried forward with the gas in form of vapor and then the gases are mixed with the producer gases proper which escape through the usual offtake. This arrangement offers the advantage that existing producers can without great costs be converted for this purpose and a better efficiency is obtained in that the glow heat with

which the coke arrives on top of the fuel bed is preserved for the producer and in addition there is naturally less dust in obviating a cooling and handling of the soft semi-coke. As promising as this arrangement looks and although it has been widely adopted, the opinion about its advantage differs greatly and the reports heard are so contradictory that the writer has so far been unable to form a proper judgment of the process with which he has not been in personal contact.

The conclusion which a close observer must draw from the development of low-temperature carbonization so far tends to show that a further growth can only be expected by a close co-operation between low-temperature process and the iron and steel industry in general. The latter, however, has hardly paid sufficient attention to the possibilities and advantages which these processes may offer in the form of supplementary plants under proper conditions.

Blast Furnace Flue Dust—100% Recovery

Present Methods of Gas Washing and Flue Dust Recovery Coordinated to Accomplish Complete Recovery and Recharge of All Flue Dust at Blast Furnace—Wash Water Evaporated at Slag Pit.

By GEO. B. CRAMP

IN THE March, 1921 issue of "The Blast Furnace and Steel Plant" there appeared an article, under similar headline and by the same author, dealing with the direct recovery of blast furnace flue dust by application of present practical methods of recovery, which properly arranged and coordinated would accomplish direct recovery and recharge of over 90 per cent of all the flue dust produced at the blast furnace; a graphic arrangement of the proposed apparatus appearing with the description.

In this paper and accompanying drawing, it will be attempted to show the practicability of the installation of such a flue dust recovery plant as above referred to, at the average modern blast furnace plant, and it will be further shown that by the addition of a simple cooling system for cooling the over flow water from the sludge settling tanks so that it may be re-circulated to the gas washer; practically a 100 per cent recovery of flue dust is effected and complete disposition of the corrosive water, resulting from recirculation, made possible by pumping it to the slag granulating pit where it is vaporized by the hot slag or absorbed by and removed from the slag pit with it, thus preventing contamination or obstruction of public water courses that result from the practice of allowing gas washer water to run freely into these bodies of water.

Figures will be presented to show that even though the sludge settling tanks may effect the recovery of as much as 98 per cent of the flue dust contained in the entering gas washer water, the power cost of cooling the overflow water for re-circulation is easily covered by the 2 per cent of flue dust remaining therein; its recovery by this means being fully justified.

As the method of sludge recovery and recharge into the blast furnace, as previously outlined and herein represented, may in some respects appear novel, or even radical, especially as regards the introduction of apparently considerable quantities of moisture into the blast furnace, figures will be given to show that the moisture entering the furnace with wet flue dust in sludge form is not excessive.

The proposition of cooling the overflow water as herein outlined, and re-circulating it through the gas washer, is,—as applies to blast furnace gas washing,—a somewhat decided departure from past or even present day practice, but the same system is followed in by-product coke plant operation at the final coolers, where water having once been used in direct contact with coke oven gas, to accomplish cooling, it itself cooled and re-circulated again and again through the final coolers; losses by evaporation in cooling the water being restored by make-up, or fresh water from the supply lines. By this means contamination of public water courses is avoided at the by-product plant, and the same method will prove applicable to the control and disposition of dirty gas washer water at the blast furnace.

The apparatus in detail and operation described in the previous article above referred to, consisted of the dust-catcher-separator, the gas washer, the sludge settling tanks, and the sludge pump, all of which are represented in the drawing accompanying this paper. The added features shown and described herein are the overflow water sprinkler troughs, the overflow water cooling closets, air ducts and motor driven fans, the individual cooled water circulating pump, the piping system to the gas washer and slag granulating

pit and the de-hydrating sludge storage tank with its sludge feed and weak sludge return pipe to the settling tank and the de-hydrated sludge pipe to the skip pit, all being in relatively correct position in plan and elevation.

Direct 100 Per Cent Recovery of Flue Dust Described.

Gas from the top of the blast furnace enters the dust-catcher-separator through the downcomers. In the separator the velocity of the gas is greatly reduced, the dust carrying capacity of the gas being also greatly

ing well in case water goes off the gas washer and the dust flushing feature is thus rendered inoperative.

The dust-catcher-separator thus permits all dust brought down in the gas-cleaning operation to be gathered together in one wash water which may be disposed of as later described.

The Gas Washer.

Here the gas is cooled and the dust washed out by contact of the dirty gas with wet baffle surfaces, the arrangement of which may be similar to that described

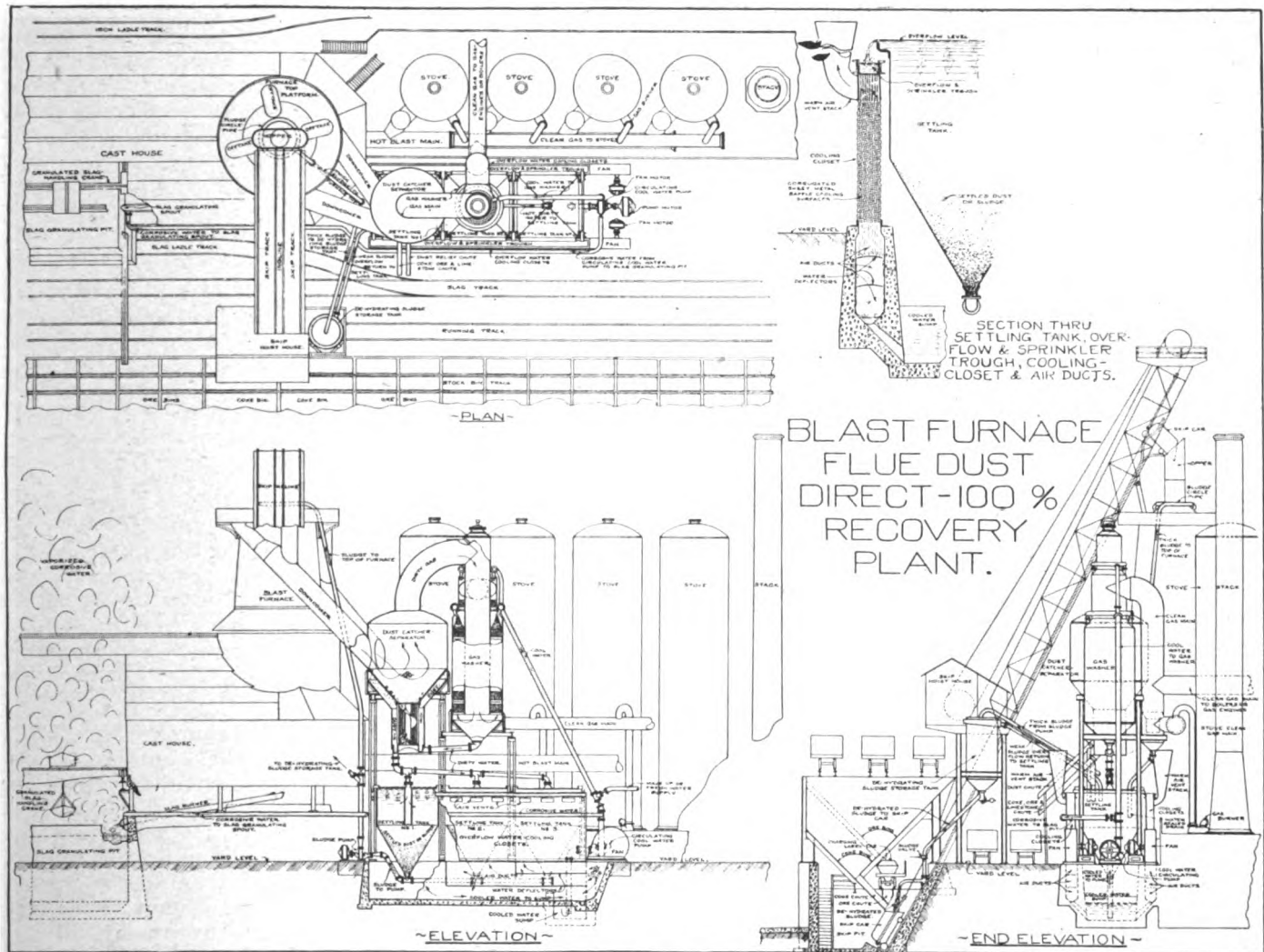


Fig. 1.

decreased as a consequence and all the heaviest solid particles in the gas are dropped into the bottom of the separator, the arrangement of which accomplishes the separation of coke, ore and limestone,—that may come down with the gas during furnace slips,—from the fine dust which later is flushed out of the dust-flushing-well in the bottom of the separator, by the same water that has previously been used in the gas washer. The bulky stock is held in the separator away from contact with water until removed through a properly constructed gate and chute which latter is provided with a grated bottom permitting any dust that may come out with the larger stock to drop immediately into the settling tank through a chute projecting into the water contained therein. A dust relief pipe may be provided to take off accumulated dust from the dust flush-

ing in the earlier article on this subject. The spacing of these baffles must conform to water distribution over them, which in this recovery and circulating system should be maintained at a minimum so that the velocity through the settling tanks will be as low as possible in order that precipitation of flue dust therein will be complete or nearly so, leaving a minimum dust content in the overflow water. Any approved type of gas washer however, may be used in connection with this recovery system.

Cooled Water Circulating Pump.

This pump, instead of being located at a station some distance from the furnace plant, is located with the recovery plant at the blast furnace where it picks up the cooled overflow water out of the cooled water

sump,—which water may contain from 1 to 10 per cent of the dust it contained on entering the settling tanks. Even though this dust content of the cooled overflow water may be constantly as much as 10 per cent, it will offer no serious obstacles to recirculation of the water through a properly designed and constructed circulating pump. By recooling and recirculating the gas washer water in this manner, whatever dust remains in the overflow water from the settling tanks is kept in circulation until it returns again to the settling tanks where it is eventually precipitated, thus preventing the loss of any dust which would occur in considerable quantities when the overflow water is permitted to run to the sewer, or a nearby stream.

The location of the cooled water circulating pump at the recovery plant offers an additional advantage in providing for disposition of the wash water after its continued reuse when it becomes impregnated with corrosive elements which make its continued recirculation undesirable, unless diluted by additions of fresh water, which operation will be more fully dealt with later.

The Settling Tanks.

These tanks are of square inverted pyramidal shape to provide the greatest capacity in a given space. They have steep pitched bottoms which permit the settled dust in sludge form to be uniformly removed therefrom, through the sludge pipe connections on the bottoms of the tanks.

Dirty wash water from the gas washer enters the tanks through a gas seal pipe projecting into the center of each tank. The total quantity of water is divided into three equal parts by the dirty water piping arrangement. One part enters each tank at the center and flows at a decreasing velocity to the overflow weir walls of the settling tanks, the precipitation of over 90 per cent of the original dust content of the entering wash water being thus accomplished.

For a blast furnace with a 24-hour daily output of 600 tons of pig iron, in the production of which 150,000 cu. ft. of gas per ton of iron is made, and a total of 90 million cu. ft. of gas produced, which requires 62,500 cu. ft. of gas to be cleaned per minute; there is required 1,600 gallons of wash water per minute at 25 gallons of water per 1,000 cu. ft. of gas to be washed.

Dividing this quantity of water into three equal parts, there would be a flow of 534 gallons of dirty water into each settling tank per minute. Space at the modern furnace plant would not permit of a much larger settling tank than 20 feet square with a capacity each of about 60,000 gallons which would permit all water passing through it at 534 gallons per minute to be retained therein approximately one hour and fifty minutes. This retention period should accomplish close to a 99 per cent precipitation in the settling tanks if this retention period is not reduced by increased water flow through the tanks; but as the tanks become partly filled with settled flue dust and the quantity of water circulated is increased,—as will be necessary in extremely warm weather,—the water will be retained a much shorter period and a lower rate of precipitation will occur.

Overflow Water Cooling Closets.

The purpose of the cooling closets is to cool the overflow water from the settling tanks in order that

the water with its low dust content may be sufficiently cool to reenter the gas washer where it will again perform the operation of properly washing and cooling the gas.

The closets are shown in cross section in the enlarged insert on the drawing, and may be composed of corrugated sheet metal baffles to afford the proper cooling surface. These baffles are arranged directly under the sprinkler troughs into which the overflow water from the settling tanks flows. The bottoms of the sprinkler troughs are perforated with $\frac{1}{4}$ " diameter holes being placed in rows aligned over each baffle sheet. The water falls through these holes in a solid stream which is broken up and distributed over the baffles on contact with them. The air which is forced through the air ducts and up between the baffles, by the motor driven fans, flattens the water against the baffle surfaces down which it flows, giving off the heat it contains to the air traveling in the opposite direction. The air passes out of the cooling closets by way of the warm air vent stacks with all the heat the water had held on entering the coolers, while the water leaves the closets at close to wet bulb temperature of the atmosphere.

The cooled water from the cooling closets drops into the air ducts directly under them, being deflected to the sides thereof by the water deflectors, and from thence the water flows into the gutter and on into the cooled water sump from whence it is lifted by the circulating pump to the gas washer.

The cooling closets run the full length of the three settling tanks on both sides, and for the maximum quantity of water to be cooled, need not be wider than 30 inches with an effective baffle height of about 15 feet and 4 inch spacing which will require no additional space for installation much in excess of the area occupied by the tanks themselves. At furnace plants where a tank 20 feet square could not be installed the tanks could be narrowed and lengthened or preferably increased in number.

There are doubtless more efficient cooling systems than that just outlined, but they are not so well adapted to conditions existing about the average blast furnace plant. One system of efficient water cooling is the spray pond, but it could hardly be made to operate to its highest efficiency possible on the comparatively low head existing between overflow and ground levels, while even the low dust constant of the water entering the spray pond would eventually fill it up necessitating its cleaning and the requisite space for its installation could not be found near the blast furnace.

Other tower coolers of greater efficiency are usually of too great a height to secure entry of water into their water inlets at the head available, making necessary their installation too far below ground level to be practicable. It would not be well to raise the tanks and other apparatus because sufficient drop of the downcomers from the blast furnace could not be secured at the average blast furnace, it being necessary to provide a good downcomer pitch to insure their self cleaning features.

The continuous requirement of 35 hp for driving the fans supplying air to the cooling closets is entirely justified by the saving in flue dust accomplished by this cooling and recirculating system, as will appear by the figures presented in the following:

From the average blast furnace there is blown with the gas about 200 lbs. of flue dust per ton of pig iron produced and on this basis a 600-ton furnace would lose 60 tons of flue dust per day. If as much as 93 per cent of this dust is recovered by ordinary processes of gas washing and flue dust recovery, there is a loss of 1.2 tons of flue dust represented in the 2 per cent that has escaped recovery. The metal equivalent of this lost dust at 50 per cent metallic content of flue dust is 0.6 tons which at \$20.00 per ton for pig iron is worth \$12.00. The cost of 35 hp for 24 hours at as high as 0.7 cent per horsepower hour would be about one-half the value of the lost flue dust, leaving a margin of \$6.00 per day in favor of the power driven cooling system, while contamination of public waterways is effectively prevented, and litigation often resulting from such stream pollution entirely avoided.

When the efficiency of the recovery system is materially reduced by increased water flow through the settling tanks, the saving in favor of the power driven cooling system becomes relatively greater.

Corrosive Water Disposition.

Repeated circulation of water through the gas washing system, as already stated, will cause the water to become increasingly corrosive, necessitating its constant dilution and disposition. This is accomplished in this system by opening and closing the proper valves in the cool water lines at the outlet of the cool water circulating pump, and without stopping the pump, directing a stream of corrosive water to the slag granulating pit and permitting fresh or make-up water to run direct to the gas washer; this operation taking place during the tapping of slag from the blast furnace.

At most modern furnace plants a slag granulating pit is provided at, or near the furnace, into which hot slag is run and granulated by projecting a stream of water against the hot slag stream from under and behind it, just as it flows from the runner or spout into the slag pit. This causes the slag to break up into granules and become very porous. The hot slag in this operation drives off considerable water in vapor form and because of its great porosity when granulated absorbs considerable water, the actual quantities involved appearing in the following:

In the production of one ton of pig iron by the blast furnace there is produced about 1,300 lbs. of hot slag. This slag when granulated and free of moisture weighs about 26.5 lbs. per cu. ft. In the cooling and granulation of each cubic foot of this slag there is required about 2.0 gallons of water which is driven off in the form of vapor, while each cubic foot of slag absorbs about 2.3 gallons of water which is removed from the granulating pit with the slag by the slag handling crane. Each 1,300 lbs. of hot slag produces 50 cubic feet of granulated slag and at the above rate of water consumption per cu. ft. of slag granulated, there would be a total of 215 gallons required for each 1,300 lbs. of slag or each ton of pig iron produced. Thus at a furnace producing 600 tons of pig iron daily, 129,000 gallons of water are required at the slag pit.

There is in the settling tanks and circulating system a total of 180,000 gallons of corrosive water that must be tempered or diluted and continually disposed of. At the rate of but 1,600 gallons of water circulated per minute, this quantity of water comes into circulation about 14 times each 24 hours and as there is a

water loss by evaporation, each time the water comes into circulation, of about 1 per cent, there would be a total daily loss of 14 per cent of 180,000 gallons or 25,000 gallons which with a disposition of 129,000 gallons possible at the slag pit would make a total of 154,000 gallons of water disposed of daily.

From this figure however must be deducted the condensed moisture coming from the gas washing or condensing operation, which may be determined about as follows:

Roughly an average of 650 lbs. or 77.0 gallons of water is driven out of the furnace with the gas for each ton of pig iron produced and a furnace of 600 tons would in this manner produce an average of 46,000 gallons of water daily, which comes into the circulating system in the gas washer. Consequently the net corrosive water disposition will be the difference between 154,000 gallons and 46,000 gallons, or 108,000 gallons daily.

The original contents of the circulating system having been stated to be about 180,000 gallons it will be seen that a complete renewal of the circulating water is possible every two days, but during this period the water is diluted by frequent additions of fresh or make-up water at slag tapping periods. Thus a minimum of corrosive elements is maintained in the water.

No reference has been made to moisture contents of the sludge entering the blast furnace in the foregoing, because such moisture is returned again to the blast furnace in form of wet sludge and no additions of water to the circulating system will take place from this operation.

This system of corrosive water disposition besides preventing the fouling of water courses, is well adapted to blast furnaces operating on ores high in valuable alkalis. These alkalis coming off with the furnace gas are taken up by the circulating water, but instead of being disposed of at the slag pit, this water with its valuable alkaline content may be piped as needed to a leaching or evaporating plant for the recovery of these alkalis.

Flue Dust Recovery and Recharge.

Flue dust in sludge form is drawn from the bottom of the settling tanks through a pipe line to a sludge pump of special design. This sludge pump may lift the sludge direct to the top of the furnace where it is distributed uniformly through properly constructed nozzles. This sludge may contain from 35 to 50 per cent of its own weight in moisture above its saturation point which is about 15 per cent of its own weight of water, making a total moisture content of from 50 to 65 per cent, and though the charging of so much moisture may seem impracticable, figures and comparisons will be given later to show that this moisture is negligible compared to the large fluctuations in moisture contents of the raw materials charged into the furnace in the usual manner.

The above moisture content of the sludge may, however, be reduced 10 to 15 per cent by pumping the sludge to the dehydrating sludge storage tank located near the skip pit, as appears in plan and elevation on the accompanying drawing. This tank is of comparatively deep depth and sufficiently large to hold one day's production of flue dust. The sludge is pumped through a pipe line entering the center and top of the dehydrating tank. The heavy particles immediately

settle to the bottom and, as the depth of the sludge increases, it displaces some of the water contained therein, which rising to the top, overflows in the form of thin sludge and is returned to one of the settling tanks for resettlement and recovery of its dust content.

The location of the de-hydrating tank at the skip pit permits the operator of the stock charging larry car to drop a charge of de-hydrated sludge into the skip car by opening the quick acting sludge valve to which he has access when his larry car is in the dumping position over the skip car.

Thus the thick sludge may be charged by the same means that all other raw materials are charged into the blast furnace, or if it may be desirable to transport sludge from the de-hydrating tank to a sintering plant or stock pile it may be dropped from this tank directly into a standard gauge car.

Flue dust charged into the blast furnace by either of the above described methods cannot be blown immediately from the furnace, and helps wet down other stock and reduces dust production in charging. It is possible, of course, that the moisture in these materials is soon driven off, leaving the dust free to be blown again from the furnace. The production of flue dust however cannot be completely cumulative, i. e., all flue dust so charged cannot possibly be blown from the furnace along with the usual quantity that would have been produced even had the flue dust not been recharged. Gas volumes and velocities determine the amount of dust produced and a given volume of gas at a given velocity will carry a definite and fixed burden of dust and cannot be made to carry more unless the velocity is increased.

Granting, however, that the dust production will, by this method of recharge, be somewhat greater than in the usual furnace operation; any additional dust that may leave the furnace is simply recovered in the usual manner and returned again to the furnace.

This system of recovery permits of a more accurate accounting of the materials charged into the furnace, because there will never be any unaccounted for losses such as occur now, where ineffective recovery of flue dust or no recovery at all is the practice.

Moisture Considerations of Recharged Flue Dust Sludge.

What may appear to be excessive moisture contents of the sludge recharged into the furnace in this system of recovery is here considered, a table of moisture contents of raw materials entering the furnace to produce one ton of pig iron being first presented.

Materials.	Weight.	Weight of Moisture Contents.		
		Mini- mum.	Maxi- mum.	Average.
Iron Ore	4,400 lbs.	375 lbs.	1,010 lbs.	575 lbs.
Coke	2,200 lbs.	22 lbs.	250 lbs.	55 lbs.
Limestone	1,100 lbs.	11 lbs.	40 lbs.	16 lbs.
Totals	7,700 lbs.	408 lbs.	1,300 lbs.	646 lbs. = 77 gals.

Between the total maximum and minimum moisture contents in the above table there is a difference of 892 lbs. of moisture, and between the maximum and average totals 654 lbs.

These wide variations in moisture contents of the raw materials entering the furnace are caused largely by changeable weather conditions to which the materials are exposed before charging into the furnace.

As great as these moisture variations are, however, they occur without serious interference to any of the furnace or gas washing operations.

From 7,700 lbs. of raw materials entering the furnace, an average of 200 lbs. of flue dust is produced. If to this flue dust is added as much as 65 per cent moisture to accomplish hydraulic charging, the amount of water entering the furnace from this source would be 130 lbs. which is about 1/7th of (892 lbs.) the difference between maximum and minimum moisture content of materials entering the furnace, and 1/5th of (654 lbs.) the difference between maximum and average moisture contents.

As it is possible to charge the flue dust by way of the de-hydrating tank and skip car with a considerably lower moisture content than that stated in the foregoing examples, the moisture content of the recovered sludge should offer no deterrent to its being charged by either of the methods suggested.

Other Considerations.

It has long been considered absolutely necessary by many blast furnace operators that flue dust be sintered, nodulized or briquetted before attempting to recharge it into the blast furnace. In the early days of the use of soft, fine or dusty Messaba Range ores, such difficulties were encountered in their satisfactory reduction and so much flue dust produced in the operation of the furnaces then existing, that it was almost generally believed for a time, that these obstacles were only surmountable by sintering or briquetting at least some portion of the fine ores composing the furnace burden, or by using a certain amount of lump or bulky ore along with the fine ores to be reduced. Developments since that time have shown however, that these difficulties were not overcome by treatment of these ores, or use of bulky ore, but almost entirely by better furnace practice and improved design, and in this direction,—no doubt,—lies the complete solution of the blast furnace flue dust recovery problem.

The idea of sintering or briquetting flue dust is to provide, if possible, a bulkier and harder product that will not be carried from the furnace in charging or in normal furnace operation; and which will of itself help maintain a more open or porous condition of the furnace burden than is possible if the raw or untreated flue dust is recharged into the furnace.

The tables showing the comparative weight and bulk of all materials entering the furnace here follow, with the object of showing how small a part of the whole furnace burden flue dust composes, and how little this dust, if immediately sintered and recharged continuously as produced, will add to the openness or porosity of the whole burden.

Materials.	Weight.	Wt. per cu.ft.	No. of cu.ft.
Iron Ore 55%....	4,400 lbs.	150 lbs.	29.3
Coke	2,200 lbs.	35 lbs.	62.8
Limestone	1,100 lbs.	95 lbs.	11.5
Totals	7,700 lbs.		103.6 cu.ft.

By Wt. Iron Ore composes 57 hundredths of the total Wt. of materials charged.

By Wt. Coke composes 29 hundredths of the total Wt. of materials charged.

By Wt. Limestone composes 14 hundredths of the total Wt. of materials charged.

By Bulk Iron Ore composes 29 hundredths of the total Bulk of materials charged.

By Bulk Coke composes 60 hundredths of the total Bulk of materials charged.

By Bulk Limestone composes 11 hundredths of the total Bulk of materials charged.

There is produced, in the operation of reducing each 7,700 lbs. of the above materials to one gross ton of pig iron,—200 lbs. of flue dust which at 85 lbs. per cu. ft. is 2.35 cu. ft.

By weight this flue dust is but 27 thousandths of the total weight (7,700 lbs.) of all materials charged into the furnace, and by bulk but 23 thousandths.

From these figures it will be seen that the coke,—and not the iron ore and sintered flue dust,—is by far the bulkiest material entering the furnace, and is therefore the material most relied upon, by practical furnace men, to maintain the desired openness and porosity of the furnace burden.

As flue dust is identically the same material as most of the burden materials, which never get out of the furnace until reduced, there should be no objection to recharging flue dust as herein proposed, simply because it is of this nature.

There is a possibility of course, that some recharged dust will be again carried from the furnace, but there can be no objection to this taking place when the same dust is recovered again in the usual manner and inevitably returns, by either of the proposed recharging methods, into the blast furnace and sooner or later reaches such a depth in the mass of materials, from whence it cannot again be carried, and gradually descending to the reduction zone its metallic value is there finally realized.

Summarily the objects aimed at in this recovery system are the complete processing of operations of blast furnace gas washing and flue dust recovery that are either in present use or known to be practicable, and so arranging or coordinating these operations that it will be possible to accomplish practically a 100 per cent recovery of flue dust at each individual blast furnace; the location of the recovery plant near the blast furnace making possible the immediate recharging of the flue dust in de-hydrated sludge form, while its proximity to the blast furnace permits of a complete corrosive wash water disposal at the slag granulating pits; contamination of public water courses being thus avoided.

Steel Foundry Makes Sugar Mill Machinery

Very Interesting Discussion on This Class of Machinery and Engineering Work—Roll Design and Manufacture, Housing and Equipment Manufactured.

By JAMES J. ZIMMERMAN*

THE present design of sugar grinding mills is a culmination of development, caused by the necessity of their performing a certain work quickly, thoroughly and economically through a set and permanent principle. This principle begins at the rolls, whose duty is to squeeze, cut and crush the cane, in this way extracting the juice, as is shown by the diagram Fig. 5. Note the rolls are set so that there are two bottoms and one top, located respectively at the points of a triangle. These rolls rotate in the direction shown by the arrows on them, thereby carrying the cane in the path of the dotted line, marked "line of cane," thus crushing it and extracting the juice.

From this you may see that the rolls require means of holding them in position, hence shafts with journals and bearings, in which these can rotate, and housings with caps, screws and other equipment to maintain them in position while performing their work. Note that the quantity of cane must vary, and adjustment of the rolls must be cared for if the extraction is to be maintained at its maximum; hence the bottom rolls have a horizontal adjustment in and out. The top rolls ride on the bottom rolls when there is no cane in the mill, and when cane passes through they are forced up against the housing top caps, which are hydraulically equipped and which in turn, by means of pressure (125 to 250 tons on each cap), from the pumps and accumulators upon the rams within them, force the rolls downward with sufficient

pressure to grip the cane, squeeze and crush it and extract the juice.

Mills are sized according to the number of stands and diameters and lengths of the rolls. For example, a nine roller 36x84-in. mill means three stands, each with three 36x84-in. rolls. The crushers are designated single and double or precrushing, and are sized according to the rolls, of which each stand contains two. Reading Iron Company manufactures all classes of mills and rolls of any size, from the smallest to those 36 in. in diameter by 84 in. long, with crushers in any arrangement and proportionate in size to the grinding mills. These rolls with shafts in them weigh up to as high as 18 tons. The same principle applies in the crushers, except that there are only two rolls to each stand, which work directly over each other, as shown in Fig. 6.

All moulds for grinding rolls are dry sand, and are formed by sweeping, in half flasks made of cast iron. (See Fig. 7.) After being swept out and faced, these half moulds are dried or baked (hence dry sand). A core which forms the rough bore of the rolls is formed in a core box and baked as is the mould. After baking, the mould is assembled and set up on its end and poured from the bottom, as illustrated in Fig. 8. After settling, they are removed from the moulds and cleaned and transferred to the machine shop for machining, a description of which will follow later.

Crusher rolls, types of which are shown in illustration, and which are either steel or air furnace iron, are cast in the same manner. They are not swept in the

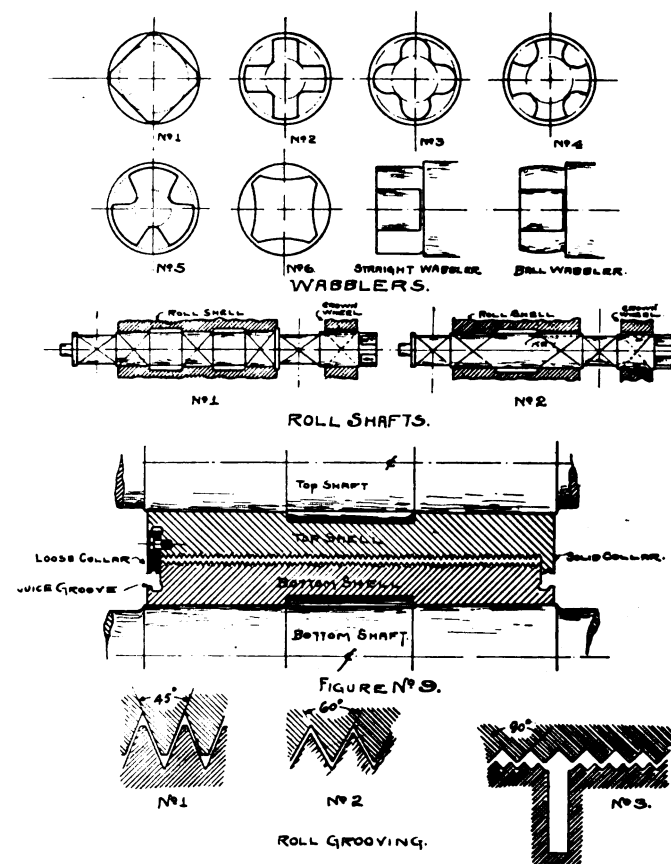
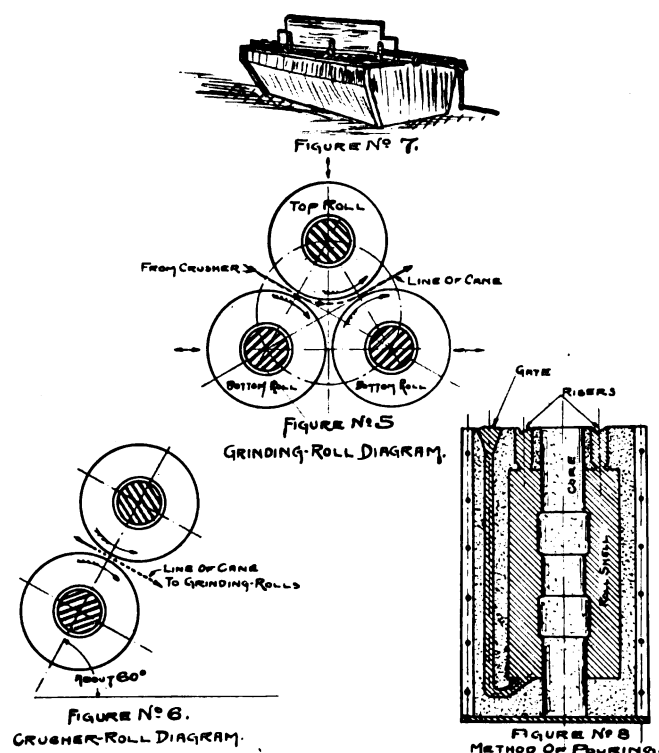
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flasks, however, due to the contour of their faces, as will be described later, but are rammed up in the flasks from either solid or sectional patterns.

When the rolls come to the machine shop, they are placed in lathes where they are chucked on the one end and run on the dead center through an internal spider within the bore, and during this setting they are tested by running a cut over the surface to determine their quality and whether or not they are spongy. They are then swung into special steady rests on the same lathe and bored simultaneously from both ends to the required diameter by means of a special double headed boring bar

shrunk-on shells are removable by proper reheating, while at the same time the shafts are forced out in a hydraulic jack or press. Probably the next best method is to force the shafts into the shells in a hydraulic press under a total pressure of 550 to 600 tons. In either case the shafts are one-eighth of an inch more or less smaller in diameter at the lead end, enabling them to come closer to their seats in the shells before being pushed or shrunk in same.

After the shells have been placed on the shafts, they are again swung in the lathes for turning and grooving.



which contains several cutting tools. They are then taken from the machine and await their being placed on the shafts.

Note in the illustration (Roll Shafts) that the longer and larger rolls are either of the three bearing type, as No. 1, or the two bearing type, Fig. 2, so formed by coring in the foundry. The lengths of these bearing points vary with the diameter and lengths of the rolls from 24 to 30 inches.

The shafts of either steel or wrought iron forgings are turned and faced in a lathe to the required diameter and fit in the shells. Many methods of fitting the shells on the shafts have been developed and exploited by various firms, mostly as talking points for salesmen, and due to this cause this company has and will continue to fit up rolls as desired. Reading advocates and furnishes rolls with all their mills with the shells shrunk on the shafts, which is beyond argument a method so secure that the shells positively cannot come loose. Again, this method of shrinking the shell on the shaft absolutely prevents any of the juice from the cane from entering and remaining between the shaft, its key and the roll shell, as is possible when other methods of putting the shaft into the shell have been used. The collection of this juice in different crevices, such as noted, permits fermentation or souring and consequently contamination of the good juice. These

These rolls, as shown in Fig. 9, contain grooves which run straight around the rolls and across their entire face, so that the grooves of the top roll fit into the grooves of the bottom roll, as especially illustrated under "Roll Grooving." The style of grooving varies with the views of the engineer, running from six to one groove for each inch of surface. They further vary in spread or shape from 45 to 60 and 90 degrees, as shown in full sized grooving cuts 1, 2 and 3, the latter being a patented form of grooving called "Messheart." In some instances where the size will permit, the grooves are chased with chasing tools, while all others are cut in one at a time.

As shown in Fig. 7, the top roll requires a collar which prevents the cane from squeezing out from between the rolls and into the bearings. These collars were formerly cast on the roll, as shown on the right, while on all recent installations they have been made separate from cast steel and are bolted to the rolls. Note that with this method the rolls become interchangeable, and should the wabblers on the top roll break off or become worn beyond use, it may be used as a bottom roll. Further, note the juice groove on each end of the bottom rolls, which catches the juice running over the roll and deposits it in the pans beneath rather than allowing it to go into the bearings.

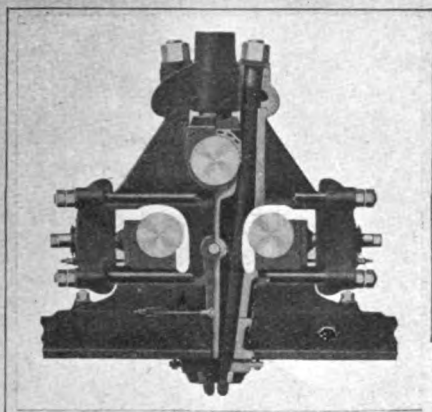


FIG. 10

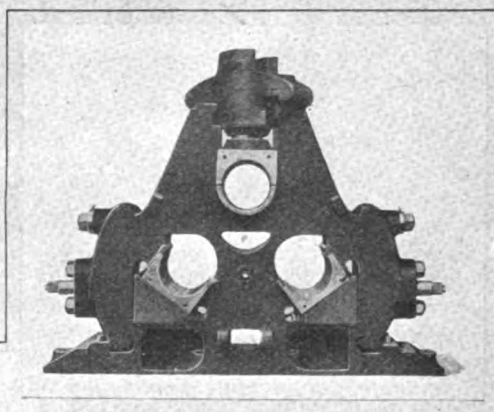


FIG. 11

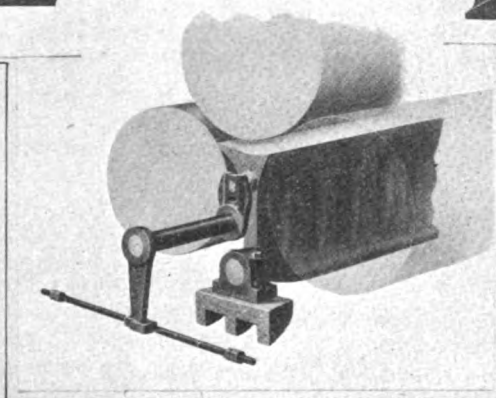


FIG. 12

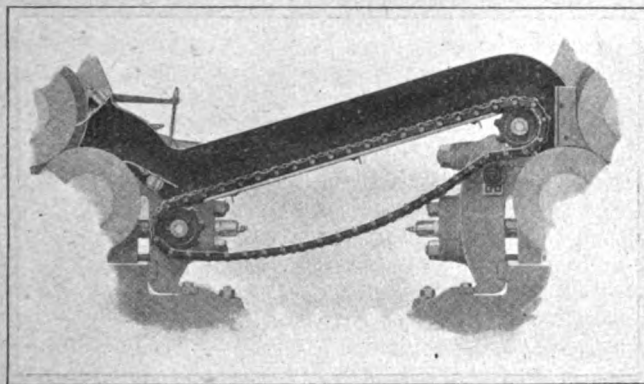


FIG. 13

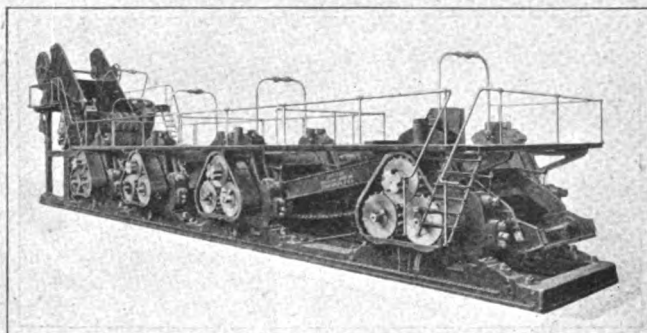


FIG. 18

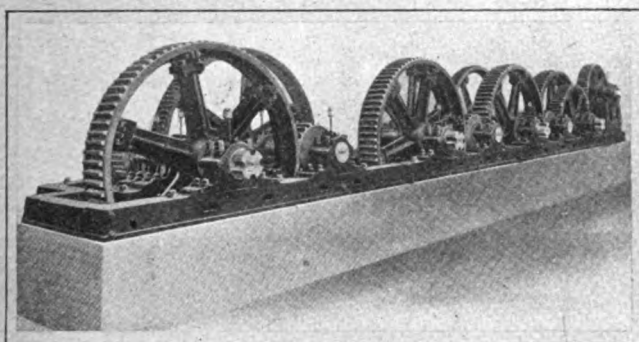


FIG. 19

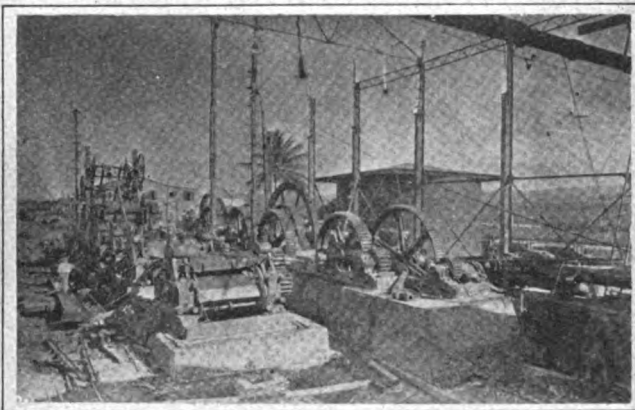


FIG. 20

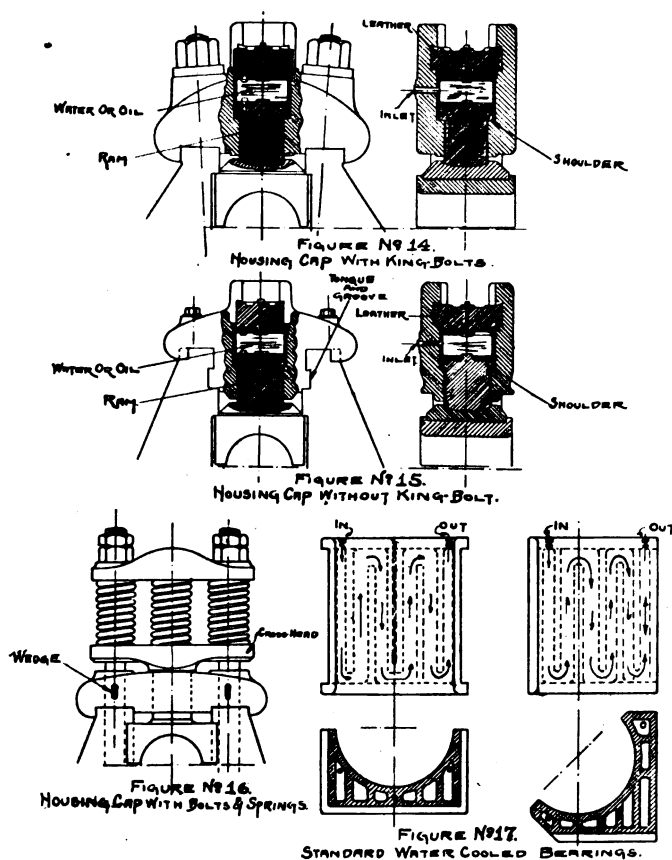
Next the top rolls are set up either on a planer or combination draw-shaper and boring machine, with the bearing journals resting on "V" blocks, where the wabblers are either bored or planed in the driving ends only. The projection on the other end is used for jacking up the roll to remove the bearings prior to removing the roll

itself from the mill. Six types of driving wabblers are shown under the illustration (Wabblers), all of which will serve their purpose. Types 1 and 4 seem to be most used, with straight faces as shown by the side view (straight wabblers). The ball wabblers are seldom if ever used in sugar mill practice, and its principle is to form

with the coupling box a ball and socket permitting, without difficulty, a greater lift of the top roll than possible with the straight type.

Housings and Equipment.

By referring to Figs. 10 and 11, you will see the two standard types of housings which have been adopted by the Reading Iron Company for heavy duty. The first type is generally known as the Rousselet housing, so named from the designer. This housing is either made of air furnace gun iron or acid open hearth steel, which is later annealed. Note that the hydraulic top caps, which receive the entire pressure of grinding, are held in position by king bolts (two for each cap), which pass through the housing and are locked and held at the base by specially designed lock wedges. The side caps, which maintain the bottom rolls in position, are tied to-



gether and to the housing by tie rods (four to each housing). Use of other equipment may be seen, hence I take neither time nor space to tell of their functions. The second type, Fig. 11, shows the standard Reading housing, which is usually made from acid open hearth annealed steel. This housing differs very substantially from that of the Rousselet design, inasmuch as the top cap is maintained in position by a special bayonet lock, which locks or unlocks by a quarter-turn of the cap, thus permitting its quick removal. In this manner king bolts are eliminated. The tie rods, which hold the side caps in the former type housing, are also eliminated and are replaced by special tee-headed bolts at the top and wedge pieces at the bottom. Adjustment, or means of moving the bottom rolls, is affected differently for each type of housing, as will be noted.

Fig. 12 shows what is termed the turn plate, with its rest bar which serves as its support, and enables it to be

adjusted through the bearings and adjusting rods at its base. The function of this turn plate is to turn or guide the cane through the two grinding passes formed by the top and two bottom rails. This turn plate is grooved with the same grooving as the bottom rolls, to permit its fitting down into the grooves of the roll itself, as can be seen in the cut, thus removing any cane which may adhere to the roll and turning it into the next pass for further grinding. These grooves are usually shaped into the plates, the pitch being regulated by a graduated plate on the screw of the shaper, which moves the table. For small grooves a tool with four to six grooves in it is used, while the wide pitched grooves are cut in separately. Sometimes, when the number of plates warrants the operation, the grooves in a number of plates are planed in one setting. In either method, strict attention is paid to the grooves fitting a template.

Fig. 13 illustrates what is termed the intermediate carriers, whose duty is to convey the partially ground cane from one mill to the next. These carriers, which span the distance between each mill and the next, are as wide as the rolls are long, and are constructed of specially formed metal slats which overlap each other, and are riveted at each side to two spans of steel roller chain, which in turn run over sprocket wheels which are driven through similar chain from sprockets on the bottom rolls. The side or guard plates, which maintain the crushed cane on the conveyor, are made from cast iron while the bottom plate, on which the conveyor slides, is made of fabricated steel plate with angles for stiffeners.

Figs. 14 and 15 show the hydraulic top caps for both type of housings, Fig. 14 with king bolts and Fig. 15 with bayonet lock. Note that the fluid, either oil or water, enters at the point marked inlet and forces the ram downward, due to pressure from the pumps and accumulators. These caps are made of open hearth steel and annealed. The tongue and groove which form the lock in the caps and housings without king bolts, are turned and bored in large vertical boring mills, large enough to permit the housings to stand up while being machined. The plugs in the caps are also held in position by a tongue and groove bayonet lock, and are removed, as are the caps, from the Reading type housing by a quarter turn, which throws the tongue from the groove and permits their being lifted out of position. Both the ram and the plug are made pressure tight by the leather packing cups which span their entire diameter and are held in place by steel plates or rims.

Fig. 16 shows an almost obsolete type of cap which is still in use on many mills, especially smaller mills. These caps are held down in position either by wedges, as shown, which pass through the cap and king bolts, or else by nuts on the bolts between the crosshead and the cap. These nuts are not shown. The crosshead is held down against the top cap by strong springs. It is in this manner that the top roll receives its downward pressure.

Fig. 17 shows the standard top and bottom roll water cooled bearings adopted by Reading Iron Company. These bearings are made from special phosphorus bronze metal having great wearing qualities and capable of resisting heavy surface loads with the minimum amount of frictional loss in power. The water course is formed by sand coring in the foundry. These cores which are dug out after casting require the highest type of workmanship on the part of the foundryman, for the slightest movement during the pouring may cause them to come loose from their anchors and float upwards, thus decreasing the thickness of the metal wall around them, which

naturally causes, if not an opening when machining, a wall which soon wears away and allows the water to escape, causing the bearing to be thrown away.

Nothing particular need be said regarding the machining policies or practices in these parts, except that where possible the housings, bearings and caps or other parts are machined in groups, as on a planer. Otherwise standard machine shop practice is followed in all work. Much attention is paid to standardization of parts and these are laid out to templates and machined to standard gauges. This is also done to assist the plantation owner, by enabling him to carry only a few spares and yet be protected against breakdowns, and to permit and make sure of extra parts fitting correctly when ordered at a date later than when the mill was installed. The assemblage of the entire milling plant in the shops of the contractor before shipping is positively necessary in order to definitely insure perfect installation when it reaches its final destination.

Fig. 18 shows a standard 12-roller mill and crusher, with Reading housings, as it stood assembled in the Reading shops prior to its being shipped to Central Cambalache, Arcecibo, Porto Rico. This milling plant consisted of four stands of 34-in. and 84-in. rollers and a 30x84-in. "Krajewski" crusher. The first three mills were driven by a 34x60-in. "Corliss" engine and the fourth was driven separate by a 26x48-in. engine of the same type. The crusher was also driven independently by a separate "Corliss" engine 20x48 in.

Fig. 19 shows the gearing for this mill and crusher through which they were driven from the engines. Note that the rims of the gears are built up in sections and that they are shrouded and made from cast steel. These rims are fit together on solid spiders, which are made of air furnace iron, but which could be and often are made of cast steel. These spiders have a groove turned in them and the gear segments a tongue turned on the pedestals where they bolt to the spiders, in this way insuring proper alignment. The teeth in the segments are not cut, but they are faced on the sides and rims to insure balance and proper meshing into the pinions. This facing and boring on the pedestals is done on a large boring mill after the ends, where the segments join, have been planed and bolted together, thus forming the complete rim. They are then fit to the spider and the entire gear is centered from the teeth and the hub is bored out. The shafts are of either wrought iron or steel forgings, the manufacture of which has been explained, and are machined in a manner similar to that detailed for roll shafts. The bearings, which are separate from the bed plates, are planed and bored in groups. All bearings except those taking the engine shafts are lined with babbitt, which is poured in them, well hammered or peened, and bored out to size. Those for the engine shafts, which are of course the crank shafts of the engine themselves, which extend to the gearing bed plates and receive the first pinion which meshes into the first intermediate gear, are bored out and receive half brasses, which are machined all over and in pairs.

After the complete assemblage of the mill, gearing, crushers and engines in the contractor's shops, they are torn down and packed for shipment. Much care must be exercised in this packing, for it is practically all exported to foreign countries by ships. This means that the parts must be crated or boxed strong enough to prevent breaking, and in sizes small enough to permit handling. In many instances the final locations of the mills are far away from any railroad, and the machinery must

be hauled in wagons. These wagons are pulled by oxen and have large wide-rimmed wheels which prevent their sinking into the mud during the wet seasons. The rolls are usually protected by lagging or strips, which cover the entire surface of the journals and grooving and are held together by steel bands.

Fig. 20 shows the above mill in course of construction at the Central, or grinding station, in Porto Rico. Note that the mill was assembled prior to the erection of the building, which carried a 10-ton crane. The absence of this crane necessitated the use of a jin-pole for all lifting during assembling. The engine for the first three mills can be seen at the right and in the distance the growing cane can be seen. Rigging can be seen for the erection of the structural iron for the building.

AMERICAN IRON AND STEEL INSTITUTE FALL MEETING

The twentieth general meeting of the American Iron and Steel Institute will be held at the Hotel Commodore, New York City, on Friday, November 18, 1921. As usual a large attendance is anticipated.

Many interesting technical papers are to be presented, among which are the following:

"Welding," S. W. Miller, president American Welding Society.

"Steel Lumber," Thomas J. Foster, chairman National Bridge Works, Long Island City.

"The Relations of the Iron and Steel Industries to the Chemical Industries," J. M. Camp, director Bureau of Technical Instruction, Carnegie Steel Company, Pittsburgh, Pa.

"Direct Process for Steel Manufacture," A. E. Bourcoud, metallurgist, 200 Fifth Avenue, New York City.

"Refractories in the Steel Plant," W. A. Hull, Bureau of Standards, Washington, D. C.

"Improvements in Port Construction in Open Hearth Furnaces," J. W. Kagarise, Edgar Thomson Open Hearth Department, Carnegie Steel Company, Braddock, Pa.

HOOVER'S AID TALKS BEFORE ENGINEERS

Federal publication of daily surveys of business conditions, similar to the weather reports, was suggested by F. M. Feiker, special assistant to Secretary of Commerce Hoover, in an address before the Industrial Engineers Conference in Springfield, Mass.

Every business man in the country, Mr. Feiker declared, is waiting for some concise authoritative daily guide to the business situation, such as the forecasts of the weather now printed in the top right corner of practically all newspapers.

Mr. Feiker also discussed the subject of the elimination of waste in industry. He said that while this country had the highest ingenuity and efficiency in the operation of its individual industries of any nation, the American industrial machine is as yet far from perfect. In summarizing the principal factors contributing to industrial waste, he mentioned: (1) Lost labor during depression; (2) speculation and over-production in booms; (3) labor turn-over; (4) labor conflicts; (5) failure of transportation, fuel and power supplies; (6) loss due to processes and materials; (7) excessive seasonal operation; and (8) lack of standardization.

The Acid Bessemer Duplex Process

Review of This Interesting Process With Tests Taken During
the Various Operations—Complete Operating Data.

By J. W. HAULMAN

A PLANT using the acid Bessemer converter as a preliminary refinery for blast furnace metal in connection with the Open Hearth furnace, which is known as the Duplex Process, has its advantages, whereby iron produced from certain ores can be utilized to better advantage by the removal of some of the impurities and thus relieve the Open Hearth furnace and shortening the time of the heat in the Open Hearth furnace by about 80 per cent.

There has been a number of these plants in operation using converters from 10 to 30 tons in capacity, and which enabled the producers to provide larger tonnages and expedite orders that could not have been produced by the Open Hearth Basic Process alone. In plants using this process it is usually arranged to have the blast furnaces supply the Bessemer converters with a suitable iron for blowing with sufficiently high silicon content to give a relatively higher temperature than is actually required and this temperature is then reduced and controlled by the addition of scrap into the nose of the converter in the earliest stages of the blow. The usual method is to completely desiliconize and blow the carbon down to about 10 per cent. This method of blowing commends itself on account of the regularity of the carbon content of the metal going into the Open Hearth furnace, and in most cases the more complete removal of other constituents.

Converter Lining.

The converters are lined with an acid lining most generally a silica rock. This silica rock showing an analysis of approximately, SiO_2 —92 to 95 per cent; Al_2O_3 —4 to 5 per cent, traces of Fe_2O_3 and MgO . The lining is started at the nose of the converter (the converter being set in a vertical position with the nose down) the nose ring is put in with stone cut to shape to form a complete circle and placed in a vertical position and are well keyed up, a Mica Schist stone serves the best purpose for this nose ring on account of it being softer and when the heat is poured into the converter there is less damage done by the iron ladle in ramming up against it, and there is less expansion in the Mica Schist than in sand stone or silica rock. From this point the stones are laid horizontally and the circular wall is then built up to within about a foot of the top when the shoulder is put in vertically and well keyed to serve as a binder for the entire wall when the converter is turned up to receive the bottom. This wall is usually from 15 to 18 inches in thickness and the stones are laid in a mortar usually made from the spalls or refuse left from the same stone in dressing, ground in a grinding pan and with the addition of a proportion of a good plastic clay, thoroughly mixed and ground fine so as to make good joints in the masonry.

The Blow.

The blow eliminates the silicon and manganese as oxides and then burns the carbon off as a dioxide and monoxide, phosphorus and sulphur are not considered as neither are affected by this process, it is with these elements, particularly phosphorus, that the open hearth furnace plays its important part. In the blowing of a heat it is essential to have the proper working temperature and it is for this reason that it is always best to have a blast furnace iron containing a higher heat producing element—namely silicon—than is actually required (not excessive as the nearer it is to the required blowing temperature the less scrap will be consumed) in order that the temperature can be better controlled by the addition of scrap. Manganese is also considered as a heat producing element to a certain extent but is very undesirable, as an iron running over 75 per cent manganese will cause a too violent reaction and cause "slopping" which will entail a high converter loss as well as it will have a corrosive action upon the lining of the converter and will result in a rapid destruction of the lining. The reactions taking place in the converter at different stages of the blow are noticeably of three different parts, namely—the slag forming stage, the boil, and the finishing stage, and may be more clearly shown by the following blowing test showing the elimination of carbon and silicon during each two minute period of the blow.

	Chemical Analysis of blown Metal.		Per cent oxidized at the end of each period.	
	C.	Si.	C.	Si.
Iron into the converter..	4.30	1.00		
After blowing 2 minutes	4.280	.75	.020	.25
After blowing 4 minutes	3.928	.40	.352	.35
After blowing 6 minutes	3.548	.15	.380	.25
After blowing 8 minutes	3.147	.06	.401	.09
After blowing 10 minutes	2.379	Trace	.768	.06
After blowing 12 minutes	1.599	Nil	.780	.00
After blowing 14 minutes	.843	Nil	.756	.00
After blowing 16 minutes	.213	Nil	.630	.00
After blowing 18 minutes	.078	Nil	.135	.00

This heat blew 18 minutes which is unusually long and which was undoubtedly due to the converter being turned down every two minutes to get the test. The oxidation would have been considerably faster on continuous blowing as each time the converter was turned down the blast was necessarily shut off.

During the slag forming stage, iron oxide is formed and the greater portion of the silicon and manganese are oxidized and unite with the iron oxide to form a double silicate of iron and manganese slag. Under normal conditions with a proper temperature, the car-

bon is not appreciably attacked until a considerable portion of the silicon has been oxidized, and what carbon has been removed up to this point are such amounts that are oxidized and pass off in the form of carbon dioxide (CO_2) and is noticeable by an irregular violet colored flame from the nose of the converter. This flame gradually becomes steadier as the temperature increases until it reaches a yellowish color, at this point the carbon begins to oxidize more rapidly as the boil commences and during the continued oxidation of silicon and manganese the greater portion of the carbon is also removed mostly in the form of carbon monoxide (CO) and the portion of the carbon dioxide (CO_2) rapidly decreases. It is this formation and escaping of this gas that causes the boil and is noticeable by the heavy yellowish flame from the nose of the converter, and the temperature is greatly increased and with this violent boil very often quantities of iron and slag are ejected from the nose of the converter. During the finishing period a small amount of silicon and the remainder of the carbon is oxidized, the carbon to monoxide (CO) as the temperature is too high to produce dioxide (CO_2). The action gradually becomes less and the flame begins to drop which shows an almost complete removal of the carbon. The flame drops very rapidly which signifies that the blow is completed and the vessel is then turned down, the blast being shut off as the converter begins to turn and the metal gets away from the bottom so as to keep the tuyeres in the bottom open. It is then poured into a transfer ladle and delivered to the Open Hearth furnace. In making up the charge for the Open Hearth furnace, two or three converters may be blown at the same time and poured into one ladle and it may be necessary to repeat the cycle of operation several times in order to give the required amount for the Open Hearth, depending entirely upon the capacity of the furnace receiving the charge which may be up to the 200-250 ton capacity type.

In this connection it might be well to add that to get iron of a uniform composition it is essential to have a metal mixer of considerable capacity in close proximity with the converters, so that a good mixture of iron produced from several blast furnaces furnishing iron of variable analysis. However, the specifications of iron for the Duplex process may be considerable broader than would be required for the straight Bessemer practice, yet it is desirable to have an iron with some uniformity. It is also beneficial to keep as much of the slag and kish from the blast furnace ladles from entering the mixer as possible as this not only tends to give trouble in the mixer but if any be allowed to enter the converters it will materially lengthen the blow, cause serious "slopping" of the heat with the attendant loss of product and hinder chemical reactions.

The blow with the resulting reactions as described above is particularly applicable to the 15 to 18-ton concentric type converter. Larger converters of the 25 to 30-ton single belly type do not always blow a charge in this way and very often show a greater variation in temperature especially in the later part of the blow, very often more carbon is burned to dioxide (CO_2) during the later part instead of monoxide (CO). In many instances the blow may not be initially too high in silicon and yet finishes at an exceedingly high temperature. This practice does not commend itself as the chances for reduction in temperature at this

point of the blow is exceeding small, being impossible to get sufficient scrap into the blow at this stage to have any material effect upon it, the only resort is to turn steam into the blast and thus endeavor to reduce the temperature somewhat. The best practice being to lower the temperature by burning the carbon to monoxide (CO) which will also have a vast saving effect upon the converter bottom, as this excessive temperature at the later part of the blow will have a tendency to allow the metal to come in closer contact with the converter bottom and thereby shorten the life of it. It is for this reason that the varying temperatures encountered in the large type converter has such a varying effect upon the life of the converter bottom and greatly increasing bottom expense.

It is a well known fact not all reactions take place in the same order or at the same time in different blows, as at one time or another some one reaction may be taking place more rapidly.

The oxidation of manganese carbide may result at a lower temperature and produce manganese oxide and carbon dioxide and the oxide of manganese along with the magnetic oxide of iron will form with the silica previously produced. On the other hand the temperature of the mixer metal may be higher and contain more silicon with the result that after the silicon has been oxidized on account of the high temperature, the silicide of manganese will then burn and the manganese carbide remain in the bath. This manganese carbide then acts as a very active reducing element and begins to reduce the silicon in the silica to metallic silicon and also reduces the magnetic oxide of iron to ferrous oxide, the result being an excessive converter loss.

In the small converter it is unusual for the carbon to be eliminated before the silicon, but in the larger converter this may be possible due to the exceedingly rapid rise in temperature and the carbon may be oxidized before the silicon is eliminated.

Depth of Metal in the Bath.

If the depth of metal in the converter be too shallow more oxygen of the air blown will escape unburnt than should do so. This unusual excess carries off heat passing off at the vessel temperature, which cools the vessel and also the charge. The proper depth of metal should range from 18 to 22 inches, and should bear the proper relation to the number and size of the tuyere holes in the bottom. These holes admitting the blast should not be larger than will allow the oxygen in the blast to be as completely consumed as possible. $\frac{1}{2}$ " or $9/16$ " holes have proven a good standard in converters ranging from 15 to 25 tons, varying the number of tuyeres with the weight of the charge to be blown, assuming 6 to 7 cubic feet of air per pound of charge. There has been a tendency to raise the blast pressure too high, in large converters, resulting in the air burning the carbon to carbon dioxide with the excessive amount of air, instead of burning it to carbon monoxide with about half the air, and then burning the carbon monoxide at the nose of the converter with the oxygen from the atmosphere, which will result at times in abnormally high temperatures in large converters and thus require an excessive amount of scrap which is the prime object of large converters to reduce to a minimum.

Control of Temperature.

If too high a temperature is observed from indications during the first stages of the blow when the

silicon begins to oxidize, it is the usual practice to get sufficient scrap into the converter to bring the temperature down as quickly as possible. The indication of the temperature can be readily seen in the first two or three minutes of the blow by smoke appearing at the nose of the converter, the earlier this appears and the larger the volume the hotter the charge. If in scrapping, not sufficient scrap has been added to the initial blow to bring the temperature within proper bounds it is usually arranged to have a steam connection into the blast line entering the converter and as a last resort, the steam is blown in with the blast, this has a cooling effect, but does not commend itself on account of the formation of more oxide of iron and tends to greater loss.

If the temperature is on the cold side the charge may be warmed up by blowing on the side, the vessel is tipped part way over, bringing some of the tuyere holes above the metal and the blast from some of the others blows through the shallow part of the bath, causing an excess of oxygen above the bath which burns some of the carbon monoxide (CO) to CO₂ and will also burn some of the iron to oxide. If necessary this may be continued for nearly the full length of the blow and may be done by tipping the vessel from side to side. The loss, however, will be considerably greater than with a normal blow.

The length of time elapsing between blows adds materially in reducing temperature in as much as the converter, especially if it has a large nose, will cool very rapidly and can be materially affected by climatic conditions, in which in a very short interval the converter has become black.

Size of Converters.

During the last few years it has been the tendency towards large converters. From an economical standpoint this remains yet to be proven if the 25 to 30-ton converter can be as satisfactorily operated and as economically maintained as the 15 to 18-ton type. It also remains to be proven if as much tonnage can be produced through this large sized converter as has been produced in the "old Bessemer days" with the small converters, as also the quality of the steel produced. Being experienced in the operation of both types, the advantageous and economical part of the large single belly converter has not clearly manifested itself to me. I know from the use of a certain kind of iron which had an extremely corrosive effect upon the linings of both, the upkeep of the large sized converters was very much in excess in cost per ton of steel produced than was the upkeep of the smaller type. The converter bottoms would stand as many blows yet the amount of refractory material required to put up such bottoms was double the amount required for smaller converter bottoms, the same being true with the stone lining of the converter, yet the tonnage produced per blow was only about 1/3 more. While the length of blow may be practically the same in both cases, the speed of operation in charging the converters and taking the heats away from it is considerably slower due to the fact that the increased weight of heats require heavier and slower traveling cranes and therefore retards the speed of operation to such an extent that the additional tonnage per blow would not be on a balance with the tonnage produced in a smaller converter with light and more active crane facilities.

Converter Bottoms.

The bottoms are put up by inserting tuyeres up

through a cast iron plate and a mixture of gannister, consisting of a gannister rock or clay brick bats mixed with fire clay and loam with a moisture of about 10 to 12 per cent, is securely rammed around the tuyeres, layer by layer until the entire bottom is filled up. They are then placed in an oven and baked at least 72 hours with a slow oven temperature ranging about 600 degrees F., and should be put on the converter as soon after coming out of the oven as possible. Great care should be exercised in the putting up of bottoms as to the grade of material used, an inferior material in the gannister will cause the gannister to eat away from the tuyeres causing short life. The holes in the tuyeres must be governed by the size of the converter and should be of such diameter as to allow the oxygen in the blast to be as completely consumed as possible which will materially aid in controlling the temperature.

Slag.

The slag volume with certain kinds of iron will run as high as 12 to 15 per cent on certain heats and has averaged 10 per cent for indefinite periods. High temperature developed by the silicon will produce a very fluid slag of silicate of manganese which will have a very corrosive effect upon the linings. The Bessemer charge is poured into the Open Hearth furnace through a nozzle and runner on the side of the ladle and when the slag appears at the nozzle, the ladle is quickly tipped back and none of the acid Bessemer slag is allowed to enter the Open Hearth furnace, the ladle is then carried back and the slag is dumped into slag bowls.

Losses.

The loss in the duplex process is greater than the straight Open Hearth Basic process, which is due to the elimination of carbon, silicon, etc., in the converter, whereas the scrap in the ordinary Open Hearth process has already withstood such a loss in its original conversion. To satisfy the slag in the Bessemer conversion about 2 per cent of metallic iron is oxidized in the converter; this together with a small loss in shot and spittings are the only losses sustained in the duplexing process not common to both processes working with the same materials.

PITTSBURGH FOUNDRYMEN'S ASSOCIATION

A. E. Blake, Pittsburgh manager of the United Gas Improvement Company, Philadelphia, who was the speaker at the regular monthly meeting of the Pittsburgh Foundrymen's Association at the General Forbes Hotel, October 17, could see no good in the present day gas producers, which he declared were relatively as wasteful of coal and heat as the beehive ovens were of coal and useful by-products, while admitting that the coal reserves of the country were ample for centuries to come, it was not too soon to begin to think of the conservation, he declared, and strongly urged the use of other means of gasification than the producer. He asserted that producer gas contained so much nitrogen as to decrease very materially its efficiency and also pointed out that since it could not be sent great distances the furnaces had to be nested close to the producers. The gas must be low in sulphur, he insisted, to avoid the spoiling of heats, claiming that on an average one per cent of open hearth heats were being spoiled by the use of poor producer gas. Coal and water gas installations were advocated by the speaker.

By-Product Coke Plant Regulation

Gas Regulation System of the Northampton Works of the Bethlehem Steel Company at South Bethlehem, Pa.—Operating Datum Show Superiority of System of Control from Battery Regulators.

By W. M. SHALLCROSS
Northwestern Manufacturing Company

THE Northampton Works at South Bethlehem is now the largest coke plant where the gas is handled under the new method, which neglects the suction at the coolers and operates the exhausters entirely from the individual regulators on the batteries. The operation of the plant demonstrates the soundness of the principle both in theory and practice, when applied to large plants as well as to small.

Under the former system, the suction was maintained as uniformly as possible at some point in the gas main, usually at the cooler inlet, and the oven regulators were then required to do the fine work of regulating at each battery. This scheme had two long-standing and much discussed defects. First, it was necessary to maintain, either manually or automatically, a cooler suction high enough to give the most distant battery regulator a safe operating margin at all times. This meant that the cooler suction had to be changed from time to time as plant conditions changed and as the oven operators sent in reports asking for more, or less, suction.

The second and most serious defect of this scheme was the tendency of the automatic suction regulators on the exhauster engines to "hunt" with the battery regulators. When two regulators attempt to maintain a uniform suction or pressure in the same gas main, even at two widely separated points, there is always a theoretical possibility of the two regulators setting up a swinging "see-saw" between themselves—one regulator opening while the other is closing—back and forth in regular periods. In about 90 per cent of the plants under the writer's observation, this theoretical possibility had become a practical fact, the regulators in the entire plant running almost continuously from limit to limit, the periods of each complete swing ranging from 60 to 110 seconds. Although this hunting can be temporarily stopped, it is apt to start at any time and will often continue for a long period.

The objections to this hunting are several:

- (1) The battery regulation is poor.
- (2) The regulators and engine valve parts are worn by constantly operating.
- (3) The steam consumption of the exhauster engines is high, due to the engines continually changing from high to low speed and vice versa. The fact that the engines have to be operated at a speed high enough to give a liberally high suction at the most distant battery also tends to lower the steam economy.

Description of System.

At the time of observation, the Northampton plant was equipped with a Northwestern complete electric system of regulation. There were three batteries in run, each battery consisting of 106 ovens with four regulators, each regulator handling gas from 26 to 27 ovens.

At that time five ovens were pushed and charged under each regulator every six hours, so that during the 25 or 30 minutes while these five ovens were being charged, the regulator opened wide, then gradually closed for six hours, until the next group of five were charged. (The gas flow was very erratic.) The shortest run of gas main to the exhauster house was 410 feet and the longest was 925.

In the exhauster house there were five 150 cu. ft. exhausters driven by two Buckeye and three Stumpf

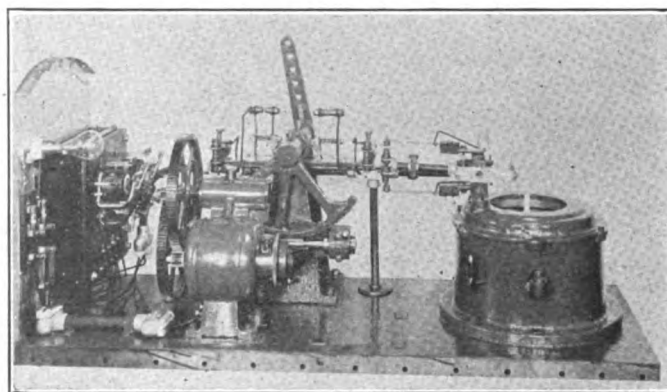


Fig. 1—Regulator with housing removed.

Unafflow engines. It was necessary to run only two at a time to handle the gas. The exhausters drew from and discharged into common headers. The speed of the exhausters was regulated by a Northwestern controller located at each engine. The Buckeyes were controlled by shifting the steam cut-off valve and the Unafflows by varying the amount of inlet valve opening at each stroke.

Each engine controller consists of a motor with gears and necessary limit switches enclosed and mounted on a floor pedestal. A shaft extends from the rear of the housing, which is connected to the valve gear of the engine. On the front of the pedestal is the control lever, by which the controller may be operated by hand—the engine speed being either raised or lowered or the system put in the "automatic control." By putting the lever in the "dead" position, the motor, with all its connections, is disconnected. Signal lights are mounted on each controller to indicate when and how the controller is operating.

All controllers are connected to a centrally located switch panel which contains the magnetic switches, relays, knife switches for hand control, signal lights and fuses. This panel is installed in a small room in which will be the gauges and recorders, making it a central point for the gas handling system. This small control room will be free from any explosive mixture of gases

which might accumulate in the exhaustor room. All contacts in the engine controllers, which might arc, are placed in gas-tight enclosures to avoid all possibility of explosion.

The regulating system was arranged to operate in either of two ways:

- (1) From hontoon switches with pressure line tapped into the cooler inlet, or
- (2) From the battery regulators.

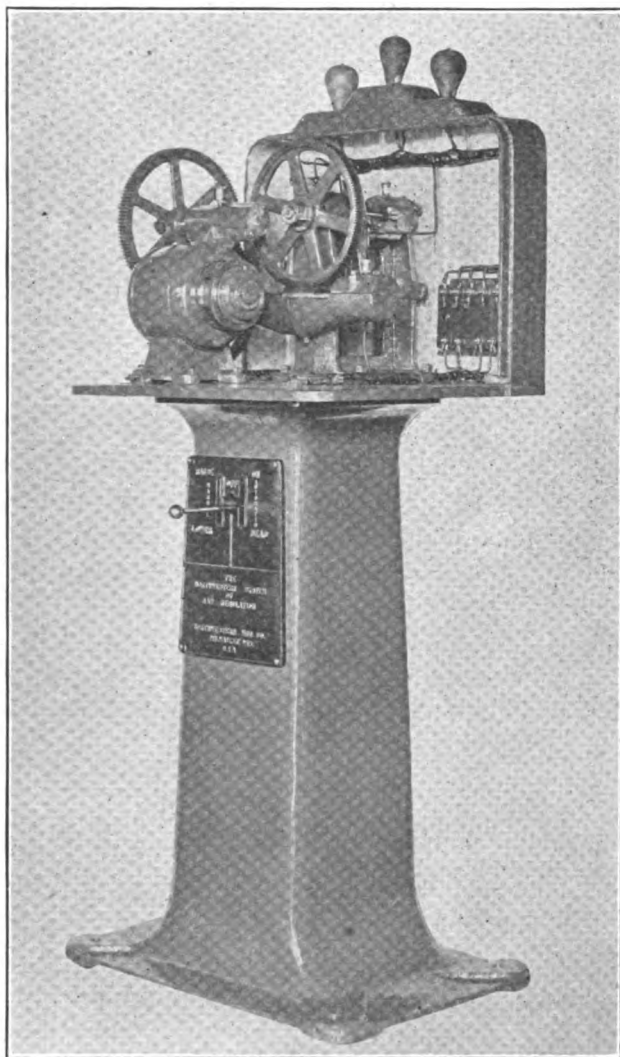


Fig. 2—Engine controller with enclosing cover off.

The hontoon switches, arranged for a maximum suction of 20 inches of water, were also installed in the small motor control room with the control panel and gauges. For operating the system from the battery regulators, each Northwestern butterfly valve regulator was provided with an adjustable contact maker by means of which an impulse was sent to the central control board whenever the butterfly valve had reached a predetermined position, both in the opening and in the closing directions.

The control switch on each butterfly regulator is adjusted so that the circuits to the exhaustor control panel are closed when the butterfly valve is about 10 degrees from each end of its travel. This allows the valve to travel 60 degrees in the clear without operating the engine controllers. There are four regulators to a battery, making a total of 12 regulators. Two batteries feed into one main and one set of coolers, while the third battery

is on a second main with its coolers. All exhaustors draw, however, from a common header.

The battery regulators are connected to the exhaustor engine control panel in such a way that whenever any butterfly valve reaches a position of 80 degrees open, an impulse is sent to the exhaustor controllers and all the engines are slowly speeded up. This speeding up continues as long as the butterfly valve is within its last 10 degrees of travel, but *only* while the butterfly valve is still opening. While the butterfly valve is stationary or while it is closing, towards its 45 degree position, it does not operate the engine controllers. This feature is to prevent hunting. In a similar manner, when any butterfly valve gets to within 10 degrees of being closed it slows down the exhaustor controllers.

The broad principle is that when a butterfly regulator is working within a zone about 35 degrees each side of the midway or 45 degree position, it is entirely able to give good regulation alone, but if it gets within about 10 degrees of either end of its travel, it must call in outside help and this outside help consists of the controllers on the exhaustor engines. There is no need whatever of the exhaustor engines trying to do any of the regulating as long as the butterfly regulators are in good workable positions.

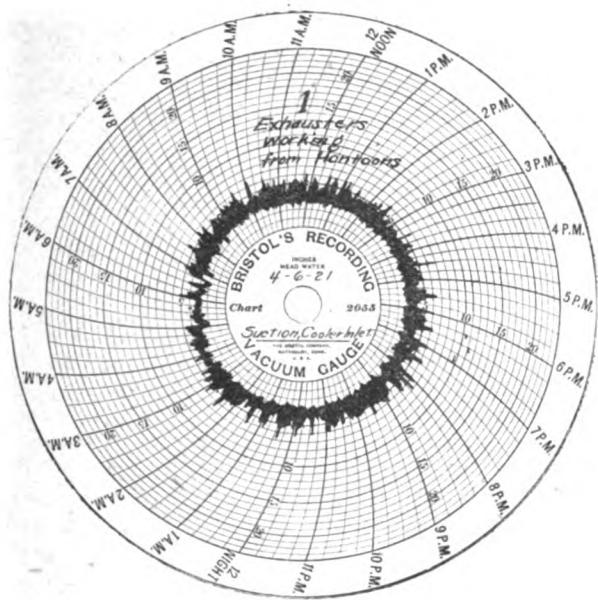
Operation on Hontoons.

The plant was operated by both the old and new method, in order to get comparative data. The hontoon switch was set to hold four inches of suction at the cooler inlet, the switch being especially designed to be perfectly dead beat to avoid, as far as possible, over-travel and hunting. The switch contacts were set so that a change of about .05 of an inch water pressure was sufficient to operate the controllers. Under these adjustments the mean suction held at the cooler inlet was four inches. The controller hunted almost continuously and it was impossible to make adjustments that would entirely prevent all hunting. The chart No. 1 shows that between 5 A. M. and 6 A. M., when there were no ovens pushed, there was no hunting and that between 3 A. M. and 5 A. M. there was very little. The controllers hunted practically all the rest of the 24 hours.

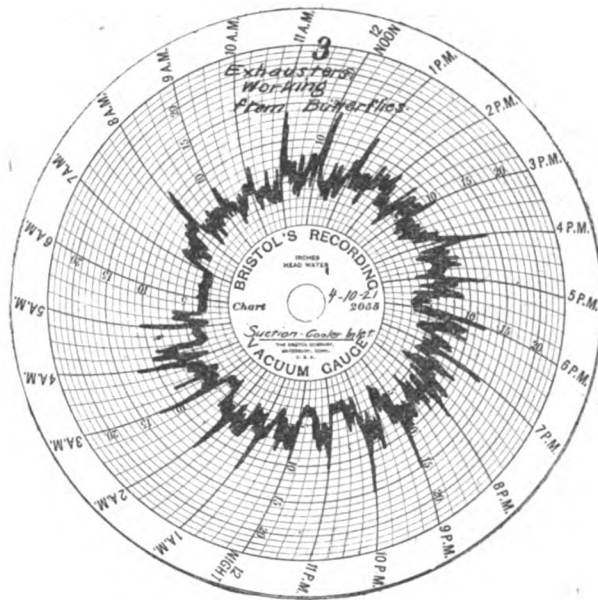
This hunting consisted of regular swings of the engine speed from high to low and vice-versa. The controllers ran continuously in one direction for about 50 seconds, rested for five, and then ran back, making the complete cycle in 110 seconds. Meanwhile, the battery regulators were opening and closing also in regular periods of 110 seconds, the battery regulators opening while the exhaustor engines were slowing down and vice versa. The battery regulators were on the average running 25 seconds out of every 60, 42 per cent of the time, and the engine controllers operated 50 seconds out of 60, 83 per cent of the time. Even with this almost continuous hunting, the regulation on the batteries was satisfactory, as shown on chart No. 2, which was an average one. The maximum variation was scarcely $1\frac{1}{2}$ mm. of water pressure with an average variation of about 1 mm.

Operation on Battery Regulators.

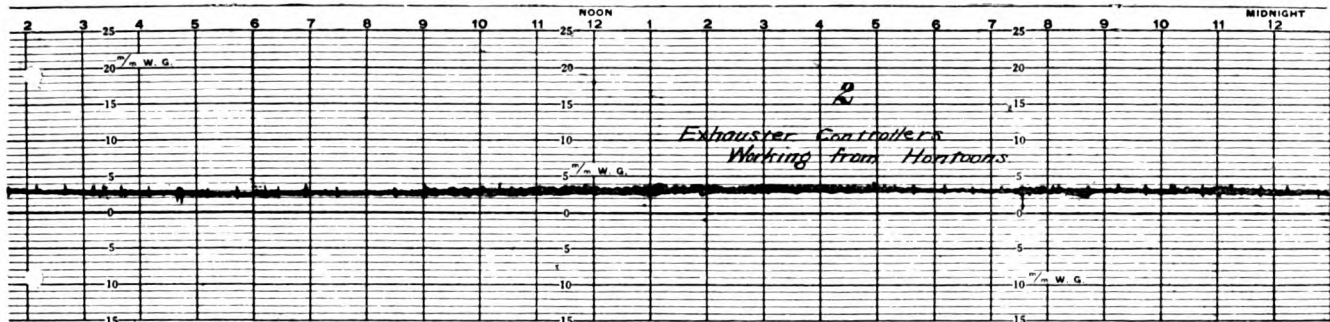
The system was made to operate from the battery regulators by throwing over a knife switch on the control board, which changed it from the hontoon control to the butterfly control. The first effect noticeable was that immediately the regulators quieted down and all hunting ceased. Repeated efforts were made to start this hunting again, but they all failed. The next effect observed was that the suction at the cooler inlet became



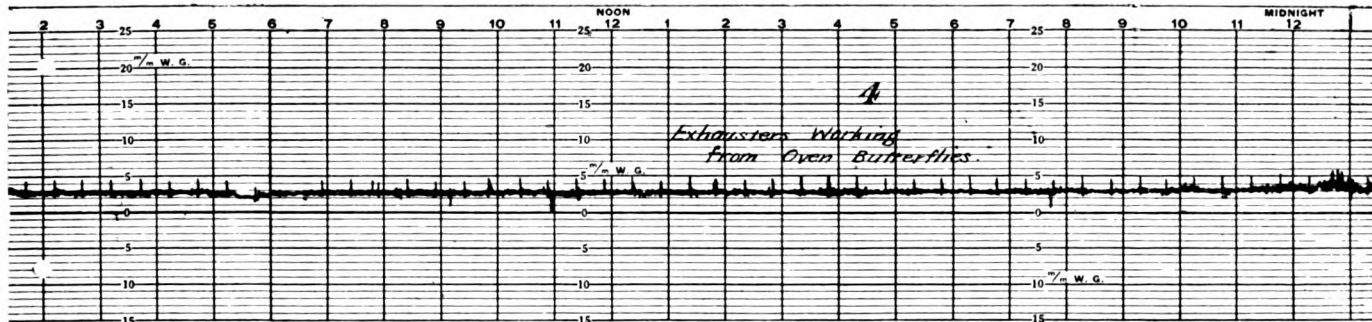
No. 1 Suction at Cooler Inlet with Hontoon Control



No. 3 Suction at Cooler Inlet with Butterfly Regulator Control



No. 2 Pressure at Ovens when operating with Hontoon Control



No. 4 Pressure at Ovens when operating with Butterfly Regulator Control

variable, as shown on Chart No. 3. This variation was to be expected, since there is no attempt made now to hold this suction constant.

The battery regulators and the engine controllers were much quieter under this system. The battery regulators averaged 12 seconds of operation out of every 60, or 20 per cent, as compared with 42 per cent before. The engine controllers operated three seconds out of every 60, or 5 per cent, as compared with 83 per cent when the system was operating from the hontoons. This great reduction of operating time of the regulating equipment—52 per cent for the battery regulators and 94 per cent for

the engine controllers—was due almost entirely to the absence of hunting, and the wear and tear on the regulators will be reduced by the same amount.

Observation of the main control panel during operation was extremely interesting. Three signal lights are mounted on the panel—a green light shows that the controllers are raising the engine speeds, i. e., the suction is too low for the battery regulators, and a blue light indicates too high a suction and that the engine speeds are being reduced. The third light, a red one, burns whenever two battery regulators reach opposite ends of their travel and one tries to raise the exhaustor speed while

the other tries to lower it. The engine controllers do not operate in either direction while the red light is burning.

At the Northampton works, because of each battery regulator getting a fresh charge of gas from five ovens only, at six-hour intervals, the red signal light flashed occasionally. At such times the two battery regulators in the extreme positions could at once be located by control board and noting which two extinguished the red light. Furthermore, the switch which lit the green lamp, as it extinguished the red, indicated the battery regulator which was too far shut, and in the same way the switch that extinguished the red and lit the blue lamps was connected to the battery in which the regulator was too far open. All the red lamp indications during the observation were mere momentary flashes, but if they had persisted the battery in trouble, as determined by the above tests, could have been at once investigated for tar stoppages, loose butterfly valve, or other trouble.

The battery regulation is slightly improved, although the regulation under the first plan of operation was very good. Chart No. 4 is a typical battery chart, the variation throughout averaging considerably less than 1 mm. When it is remembered that this 1 mm. is only one nine-thousandth of an atmosphere, the regulation is remarkably close. The rises in the pressure at regular half hourly intervals, as shown on the charts, are caused by reversal in the generators.

Steam Economy.

The most remarkable improvement in operation was the decrease in steam consumption of the exhaustor engines. This increased economy seems considerable. A careful series of tests are now being carried out to complete data on the subject.

This steam economy when operating the engine controllers from the battery regulators seems to be largely due to the absence of hunting. The writer believes that if careful tests were made on steam consumption of an exhaustor engine, both while hunting and while running uniformly, it would be found that the non-hunting engine pumped the same gas with far less steam. An engine which is continually speeding up and slowing down is necessarily a wasteful machine.

In the past, high steam economy in the exhaustor house has never been held up as a much desired goal because steam was cheap in a coke plant and the by-product plant was always, and still is, a good market for low pressure exhaust steam. However, now that waste heat boilers are being replaced by regenerators and all fuel is becoming expensive (even coke breeze is coming to have a price on it), more and more attention must be given to steam economy and the new apparatus or new method of operation which saves steam will be the one which will receive the best attention.

Conclusions.

In general, it can be said that the operation of the plant, on the two systems of control, for the purpose of getting comparative data, showed an enormous superiority for the system of control from the battery regulators, over that of maintaining the suction constant at the cooler inlet. The points of advantage may be listed in the order of their importance, thus:

First—A very material steam saving.

Second—Less wear and tear on the regulating equipment.

Third—Improved battery regulation.

Fourth—Less attention because of the non-fixed suc-

tion. But first and foremost stands the steam economy which overshadows all the rest and which alone would justify the newer system.

STUDY OF DEPRECIATION AS IT RELATES TO PRODUCTION

Of unusual interest to the implement industry is a study of depreciation as it relates to production just made by the Fabricated Production Department of the Chamber of Commerce of the United States.

The results of the investigation are given in a pamphlet issued by the department. This pamphlet offers suggestions to ease the burden of depreciation in this period of business recovery; notes the importance of obsolescence; discusses the relation of depreciation to fire insurance; includes and explains a useful form of property ledger; points to the great need of establishing standard or guide rates of depreciation in all commodity lines; and emphasizes the great importance of including depreciation in every day current costs.

"Each twist of the handle and blow of the hammer help to wear out plant and equipment, and the particular job or process that causes this loss should bear the cost," according to the pamphlet. "The basis of lower prices must be a greater efficiency and complete costs. To that end everything turned out by the factory should bear a proportional cost of depreciation."

The advisability of adjusting depreciation to production is carefully developed in the pamphlet. It is set forth that "during war-time, production equipment was operated at a pressure far above normal, entailing extraordinary wear and tear, to compensate which an extra allowance for depreciation was recognized as necessary. If this was so, if excess operation meant excess depreciation, is not the converse true? Does not light operation warrant scaling of depreciation? Are manufacturers not justified in minimizing their losses by adjusting depreciation charges to the flow of depreciation?"

Attention is directed to the need of giving the factor of obsolescence the consideration and allowance it ordinarily deserves when determining the useful life and rate of depreciation of machinery and equipment. On this point, the pamphlet avers that "property is most generally replaced before it wears out by something bigger and better. Give the American business man a machine that will render better and cheaper service, and he will scrap his present equipment, even though the paint has not worn off."

The pamphlet makes a plea for business men to abandon rule-of-thumb rates of depreciation, to study their own depreciation situation, and check their experience with that of their trade group.

"The best judgment regarding depreciation would be only an approximation frequently belied by subsequent experience, but there is a difference between gussing and estimating. A guess cannot be justified. It is a hit or miss affair. An estimate of depreciation attempts to take in all the factors governing a given situation, to assign weights and importance to them, to rely upon past experience and actual inspection of property, to differentiate between the various kinds of machinery, building, etc., and to apply depreciation with reference to a particular asset or a group of assets."

For the proper recording of depreciation, the pamphlet provides a useful and simple form of property ledger.

New Heat Treating Plant for Motor Parts

Describing the Plant Where Parts for the Nash Four Are Carbonized, Hardened and Drawn—Orderly Arrangement of Furnaces, Quenching Tanks, Etc., in Modern Building Is Noted.

By CLINTON A. ARMSTRONG, Chemical Engineer,
Chicago Flexible Shaft Company

THE Nash Motors Company of Kenosha, Wis., builders of the Nash Six motor car, entered the market with a Nash Four at the Chicago Automobile Show in 1921, a car which is a replica of the larger car in many respects.

For the building of this car the Nash Company erected a plant in Milwaukee, Wis., near the southern city limits, on a plot of ground which will give them ample room to enlarge the plant as the demand calls for it. At present the plant is equipped for and producing about 50 cars per day.

The equipment and layout of the plant are in agreement with the most approved practices of today, and the heat treating department, that part of the plant in which we as a class are most interested, is no exception.

The heat treating department is housed in a separate building just east of the main plant, designed especially for the purpose. The building, 80 feet square, of steel frame construction, has a 30-foot central corridor 25 feet high, with 25-foot bays on either side 16 feet high. The walls are of hollow tile for the first 5 feet, surmounted by 10 feet of steel sash with frosted glass panes running around the entire four walls of the building, thus making the shop light and cheerful. The roof is of concrete tile, a type of construction which is cool in summer and warm in winter. The central bay is 10 feet higher than either side bay, and advantage is taken of this to insert more steel sash with swinging sections for ventilation.

The large 20-foot doors placed in the center of each end aid in ventilation during the summer and help reduce conveying problems.

The layout of the plant, Fig. 1, is simple, yet efficient.

The five Stewart carburizing ovens, it will be observed, are located just to the right of the center of the room and are served by a small industrial railway car, the tracks of which are directly in front of the ovens. On this track cars are operated which have platforms of fire brick at the same height as the furnace hearths (see Fig. 5), thus making the transferring of loaded or heated boxes to or from the furnaces a very simple proposition.

Another very good practice made possible by the use of the transfer car is the packing and cooling of all boxes in a special room just east of the main building. This practice is conducive to cleanliness in the main room and leaves the main corridor clear for trucking.

Eight Stewart semi-muffle heat treating furnaces, 15 in. high by 24 in. wide by 36 in. deep in size, occupy almost the entire length of the north wall of the room. These furnaces are extra heavily insulated, thus making the maintenance of an even temperature easier. These furnaces are also served by an industrial railway located just south of the quenching tanks, a feature we will discuss later.

The cyanide, lead and oil tempering furnaces are grouped in the northwest corner of the building, near the door, and are served by a quenching tank identical with the rest of the tanks.

Directly in front of the heat treating furnaces are located the concrete quenching tanks, each serving two furnaces. These tanks are noteworthy as they are of concrete, 7 feet long, 3 feet wide and 8 feet deep, elliptical in shape, with two feet above the surface of the floor. In one end of the tank a 24-in. cylindrical oil quenching tank is suspended, thus making use of the circulating quenching water for partially cooling the oil.

The quenching oil is fur-

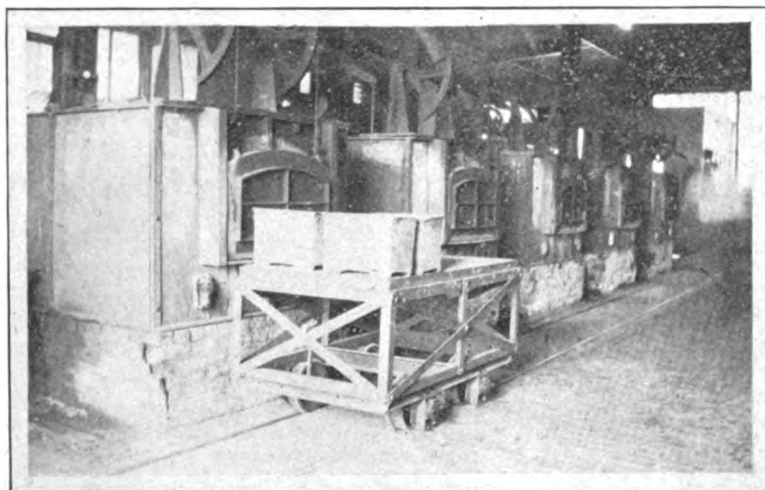


Fig. 5—Stewart carbonizing ovens with industrial railway car in the foreground. This car makes the matter of loading and unloading the heated boxes a simple proposition.

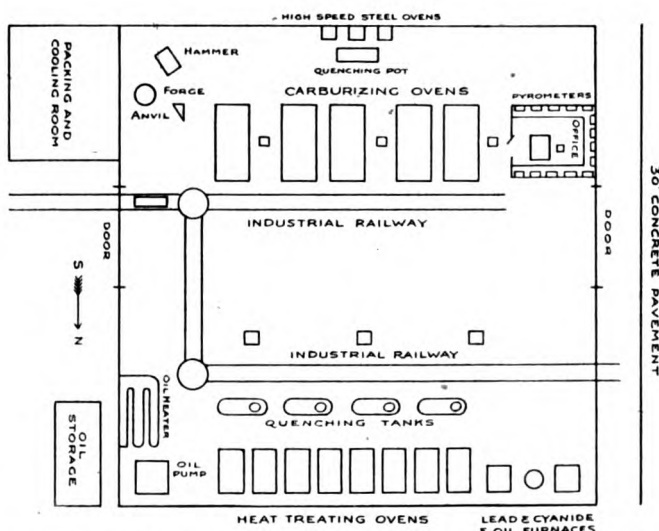


Fig. 1—Sketch showing the layout of the heat treating department of the Nash Motors Company at Milwaukee, Wis.

ther cooled, however, by circulating it by means of a 200 gal. per minute Deming rotary pump through a double tube radiator at the east end of the door, through the center of which the circulating oil flows. This practice keeps the quenching oil at a low temperature, and serves to partially heat the fuel oil at the same time.

The heat from the circulating quenching oil, however, is not sufficient for extreme winter weather, and at such time steam is turned into a heating coil located in the bottom of the 25,000 gal. storage tank buried just outside.

Fuel oil is supplied to the furnaces at 50 lbs. pressure by means of a direct motor driven Deming 150 gal. rotary pump, and in accordance with the most approved practice the oil system is of the full flow return type.

All fuel oil, quenching oil and water pipe lines are placed in covered trenches located at the rear of the furnaces and between the rails of the industrial railway running alongside the quenching tanks, thus making them readily accessible in any emergency, and at the same time entirely out of the way.

The industrial railway has been found to be of inestimable value for the handling of the work. The tracks run along the front of the carburizing ovens, with turn-tables at either end and cross tracks interconnecting the two, thus making the transfer of work to and from the ovens an easy matter. The cars are ball bearing and operate with very little effort.

Air for the furnaces is supplied by individual, direct connected, motor driven blowers at 14 oz. pressure.

Not the least interesting of the Nash equipment is the high speed steel hardening

unit. This consists of a small forge for light forging and tool dressing; an oven furnace for preheating the tools or material to a temperature of 1200 deg. F., and a high speed steel oven furnace, to which the material is transferred for the final hardening heat. The high speed

steel furnace is equipped with carbofrax hearth and supports, which have a high heat conductivity and high mechanical strength, enabling the furnace to stand up under the severe service demanded in such work. The gas carburetor at the right of the furnace aids in the maintenance of a soft reducing atmosphere within the interior at all times. Gas fuel is used entirely for the high speed steel work.

The temperature control system is very complete, and consists of 17 Leeds & Northrup indicating, recording and signaling pyrometers, housed in the office just to the right of the west entrance. This system consists of the pyrometer in the office and an indicating dial on the top of each furnace, with a plus or minus scale of 50 deg. F., together with three different colored lights which light or go out upon a 15 deg. plus or minus variation from the predetermined temperature.

The work going through this plant consists of the spline shafts, axles, drive shafts, forgings, or all parts of the car requiring heat treatment, except the transmission gears, which are hardened in a separate department by the Hump method.

All parts to be carburized are delivered to the packing room just east of the main room, where they are packed and loaded onto the cars ready for placing in the ovens.

All parts to be annealed are sent directly

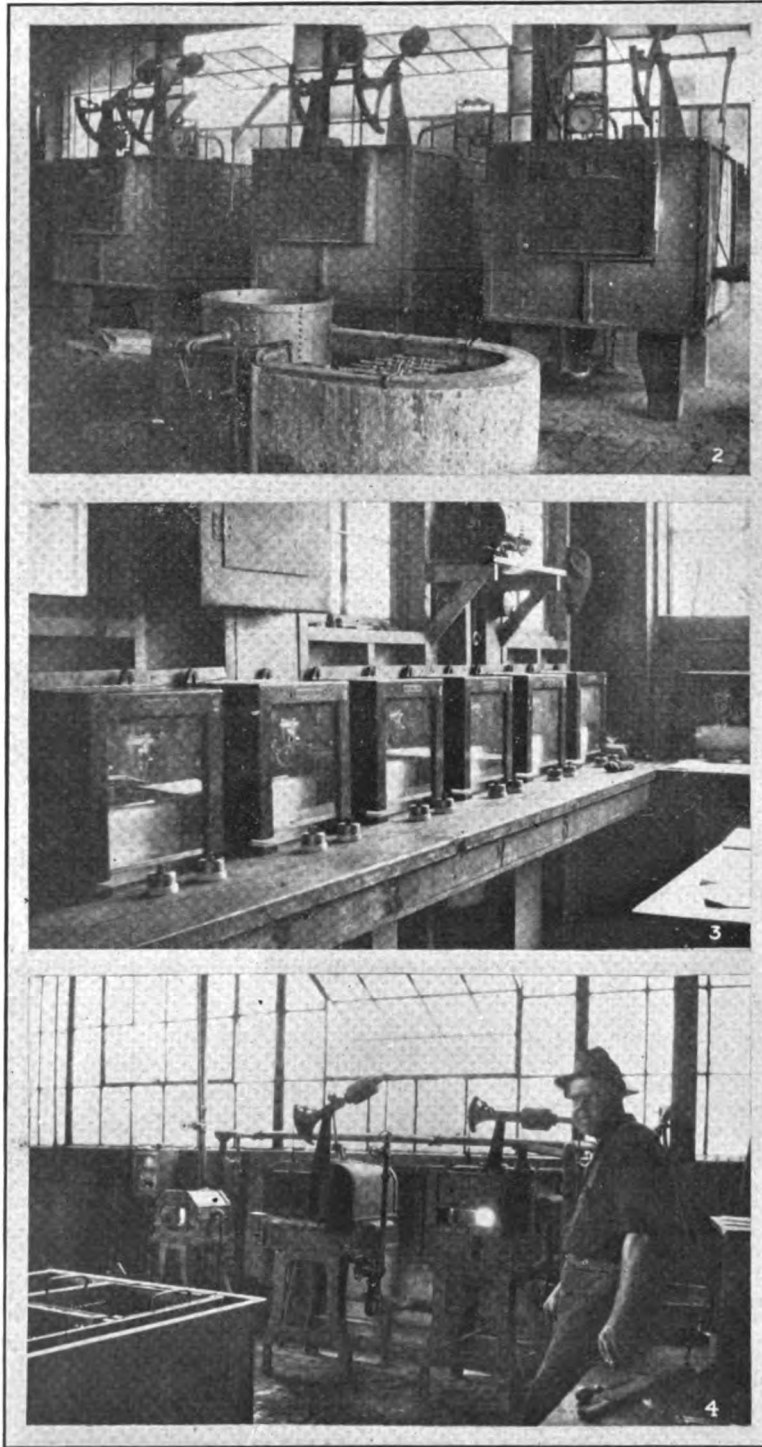


Fig. 2—There are eight heat treating ovens similar to those in the above illustration. Four quenching tanks are provided. These tanks are filled with water, but in one end of each is suspended a two-foot cylindrical oil tank.

Fig. 3—Seventeen Leeds & Northrup indicating, recording and signaling pyrometers are housed in the office for control of all the furnaces.

Fig. 4—The high speed steel hardening unit consists of two preheating furnaces and a high speed steel hardening oven and a quenching tank similar to the one shown in Fig. 2.

to the furnace scheduled to do the work, and for this work the heat treating ovens are also put into service, as they are semi-muffle and can handle small pieces very readily.

All parts to be hardened, such as differential spiders, axles, etc., are delivered into allotted spaces in the main corridor, or on an industrial railway car to the furnace; and, after being hardened, they are placed in boxes or

trucks, depending upon their size, and delivered to the oil and lead tempering furnaces just to the left of the entrance, or are transferred to the inspection department in the main plant just adjoining.

The entire furnace equipment for this plant consists of Stewart Industrial Furnaces, supplied by the Chicago Flexible Shaft Company of Chicago.

Russian Iron and Steel Industry

Some Recollections on Iron Mines, Coal Fields and Steel Mills of Russia Before the War.

By VALENTINE J. GUDKOV, E.M.

FIRST of all, let us consider the deposits of iron ore in Russia. The general reserves of iron ores in that country were estimated by the Russian Geological Survey in 1910 at 2,200,000,000 tons, which corresponds to 1,100,000,000 tons of pig iron. This estimate must be considered as considerably below the exact figures. It expresses only the total of the iron ore reserves in certain deposits. The extent of exploration does not permit expression in definite figures. For instance, the estimate for the immense area of Siberia, which has been explored very little for iron ore, has been placed at about 27,000,000 tons. To what extent this influences the grand total is shown by the fact that the exploration made in 1912-1914 of the three iron deposits in the Ural, Blagodatskiy, Bakal and Kamensk raised the estimate of the iron ore reserves for the Urals from 282,000,000 tons, as calculated in 1910, to about 400,000,000 tons of ore, or more than 48 per cent.

Very conservative estimates of the explored deposits made by the speaker in 1915, gave the following figures:

Southern Russia	900,000,000 tons
Ural Mountains	500,000,000 tons
Central Russia	900,000,000 tons
Siberia	100,000,000 tons
Caucasus	20,000,000 tons

A grand total of 2,420,000,000 tons of iron ore, or 1,200,000,000 tons of pig iron.

However, as a matter of fact, the large total reserve credited to the Central Russian District is less important than it seems, due to the thinness of the ore bodies.

From an international point of view, the ore deposits of Southern Russia are the ones which require most attention. These reserves are chiefly ores of two types, which have also a different geographic distribution. They are:

1. Hematite, which occurs in conjunction with metamorphic schists in the region of Krivoi Rog. These ores range from 50 per cent to 70 per cent metallic iron, with .01 to .06 phosphoric acid, 2-11 per cent silica, 7-35 per cent aluminum and traces of sulphur, lime and magnesia less than 1 per cent and manganese from .02 to .08. They were extensively worked until

November, 1917, and there still exist 100,000,000 tons that will grade over 62 per cent iron, and 300,000,000 tons with 50 per cent metallic iron.

2. In the Kertch Peninsula deposits of poorer grade ores are found, but their relatively low iron content (around 40 per cent) is partially offset by advantages of location, and by the large tonnage available, estimated at some 500,000,000 tons. The ores are brown hematites associated with Pliocene beds, and range from 38 per cent to 42 per cent in iron, 1 per cent to 8 per cent manganese, 1.5 per cent to 2 per cent phosphorous and 14 per cent to 17 per cent silica.

In the Urals, with the exception of the Bogoslovsk Mining District, iron ore deposits have not been explored. We can mention here the Comarovskiy Deposits with 100,000,000 tons of brown hematite of 55 per cent metallic iron, Bfagovlinsky with 75,000,000 tons of ore with 58 per cent of metallic iron, Bakal with 75,000,000 tons of brown hematite with 60 per cent metallic iron, Blagodatskiy with 50,000,000 tons of magnetic ore of 65 per cent metallic iron, and several others ranging from 50 per cent to 68 per cent metallic iron. Vast stretches in the Southern and Northern Urals are absolutely unexplored and undeveloped, but geological data furnishes a basis for the belief that further prospecting and exploration will lead to the discovery of additional deposits of iron ores.

In Siberia several centers of iron industry have been definitely indicated. The biggest deposit is situated in Kufneskiy District, which was fully explored by Professor Gudkov of the Tomsk University. At the Southeastern border of this district, near Lake Teletsk, are deposits of 68 per cent magnetic, the extent of which is very conservatively estimated at 25,000,000 tons.

Within the boundaries of the Kirkif Steppes there are deposits of hematite and magnetic ores containing 60-63 per cent metallic iron, which amount to 25,000,000 tons. In the Enisei District there are a series of iron ore deposits, chiefly magnetic ore. Of these the most thoroughly explored are Abakanskiy with 3,000,000 tons of 70 per cent magnetic ore, and Trbinskiy with 8,000,000 tons. In Irkutsk District the iron ore deposits are magnetite of 58-65 per cent iron, which stretch northward from the line of the

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Siberian Railroad along the River Angara and its tributary the Oka. The amount of ore in the four deposits that were worked for a few years was estimated at 10,000,000 tons.

On the Far Eastern Coast a considerable amount of iron is indicated in the Primarskoje District near Olga Bay and Vladimis Bay, where a number of deposits of magnetite with up to 60 per cent of iron are known. The amount of that ore is estimated at about 8,000,000 tons.

The Caucasus is more productive of non-ferrous metals than iron. However, at Chataksy, six miles from Tiflis Darkessen, twenty miles from Elizavetport, there are several deposits of hematite ore, with 65,000,000 tons of 60 per cent magnetite. Other ores are also found there.

Man-power, supplemented by domestic animals, carried out all the mining operations. The pick and shovel removed the earthy covering and subsequently the ore was hauled away from the opening to ore dumps in wagons or carts to the railroad cars. Underground mining was conducted with the same crude appliances. Beginning in 1910, considerable progress was made in mining, altho there was nothing special that would be interesting or new to the American miner.

The average price in the Ural Mountains for one ton of ore, 55 per cent, was \$3.00 fob. mine. In Southern Russia it was between \$5.00 to 6.00. It is interesting to note that several Ural Mills were equipped with special furnaces for working the magnetic ore, in order to transform magnetic oxide to ferric oxide. Ore was crushed partly by hand and partly by rock crushers. Magnetic concentrates hardly existed, with one exception—the Vidlitsky Mines in Northern Russia. Agglomeration was practiced at Vidlitsky and Kerchensky works with satisfactory results.

Coal Fields of Russia.

The deposits of coal in Russia are all in the more or less explored districts—namely Donetsky, Uralsky and Kuznetzky. Out of the total deposits of pit coal in the Donetsky region, amounting to more than 65,000,000,000 tons, the proportion of bituminous coal is about 18,000,000,000 tons. If we take into consideration the fact that from the time of the discovery of the Donetsky Coal District, up to the present day, the total quantity of coal mined is estimated at not more than 300,000,000 tons (less than 2 per cent of the total deposits), then we can see clearly that the time to speak of the exhaustion of the coal deposits in the Donetsky District has not yet arrived.

The Ural region is in a less favorable position. Thus far deposits of coking coal have not been discovered, although pit coal and lignite were mined in several places—Abamelek, Lafareff, Bogoslovsky and Agilrky, together with a few others.

The Kuznetzky District in Siberia was thoroughly explored by the teacher of the speaker, Mr. Lootogine, one of the most prominent Russian Coal Geologists. The object of his exploration was to obtain data for the purpose of compiling a geological map of the district, and it has now been proved that the Kuznetzky District contains deposits of coking coal of a magnitude far surpassing that of the Donetsky coal reserves. The aggregate thickness of the Kuznetzky coal vein, com-

prising six distinct beds, is 300 feet, whereas the total thickness of the Donetsky coal bed is only 70 feet.

After some preliminary exploration, the Kuznetzsky Company began, in 1913, to equip two main coal mines, the Kolchugino and the Kemerovo mines. Coal mined in 1913 amounted to 10,000 tons; in 1914, 50,000 tons; 1915, 70,000 tons; 1916, 210,000 tons and for 9 months of 1917, 250,000 tons. At Kolchugino mine four flat dipping veins of cherry coal were marked, having a respective thickness of 3.5 feet, 1, 8, 7 and 14 feet. At Kemerovo mine the coking coal beds were under exploitation as follows: one at a thickness of 35 feet, one at 14 feet and two at 7 feet, the angle of the dip being 45 degrees. In the neighborhood of Irkutsk there was the Cheremkorsky mine, with an annual output of 1,000,000 tons of non-coking coal; and in the region of Vladivostock, the Suchan mine, having an annual output of 40,000 tons of non-coking coal.

Excepting Kamchatka and the region to the north of it, there are several deposits of bituminous and brown coals. All of the former are of the Furassic period. The brown coals are upper Tertiary. On the island of Saghalin and in Kamchatka the coal bearing strata are much the same as in Japan, Canada and Alaska. The value of the deposits on the mainland is purely local, whereas Saghalin coal might become of world wide importance could the development and transportation difficulties be solved.

Most of the Donetsky seams are of high dip and therefore they are usually opened from a vertical shaft by rock tunnels driven at regular intervals.

Steel Mills of Russia.

Steel mills of Russia may be divided into four groups as follows: 1. Northeastern and Baltic group, with Petrograd as the center; 2. The Urals; 3. The Central group with Moscow as the center; 4. The Southern group.

In 1913 the production in long tons of these groups was as follows:

	Pig 500	Bessemer	O. H. 168,500	Beams & Shapes 175,430	Plates & Sheets 36,500	Rails 180
1	923,700	45,100	890,500	244,340	277,700	133,440
2	250,900	100	243,000	198,780	104,830	0
4	3,101,290	750,900	2,031,200	1,268,700	448,700	4,740
Totals	4,276,390	796,100	3,333,200	1,887,250	867,630	138,360

The Pig Iron in group No. 1 was produced at Segovetz in the Government of Olonetz, by cold blast, in small charcoal Blast Furnaces. The burden was a mixture of carbonate and magnetite, with an average content of 50 per cent metallic iron. The steel ingots, 113,300 tons—of which the Poutiloff Works of Petrograd produced 70,800 tons—were made in five private and three Governmental Works. The Poutilovsky mill was employing 12,000 men who were engaged in building ships, making guns, shells, locomotives, cars, tool steel of very high quality, shapes, ingots and so forth.

The Pig Iron in group No. 2 was produced by some twenty private companies, 761,200 tons, and 12 government plants, 162,500 tons; the open hearth steel by 19 private plants, 809,100 tons, and 13 government plants, 81,400 tons. Some of these plants, both private and state owned, produced puddled iron (23,608 tons); steel (3,970 tons), and one plant of Nizny Ialda

produced Bessemer ingot (45,100 tons). Flatuurt government plant crucible and electric steel production amounted to 430 tons, besides the tonnage given in the above table.

All the pig iron was produced with charcoal, except in the furnaces of the Bogoslovsk Mining Company, who used dried raw wood, and a mixture of raw wood and charcoal. There was no coking coal in this region, which was the cause of the low output of blast furnaces. The largest tonnage of a single blast furnace did not exceed 125 tons per day, and the smallest on cold blast was as low as 15 tons a day. The fuel for the open hearth furnaces was raw wood, and in Bogoslovsky district brown coal and blast furnace gas.

The mineral wealth of the Urals cannot be developed to the fullest extent until coke can be delivered to the blast furnaces more cheaply than at present, either by rail or water.

In 1913 the six largest producers of both pig iron and steel were as follows:

	Pig Iron	Steel Ingots
Bogoslovsky	169,300	180,000
Demidovsky	91,000	53,800
Alapaevsky	58,700	40,000
Kamsky	56,200	78,100
Balasheff	53,000	20,800
Shouvaloff	51,800	57,000

In group No. 3, including the Moscow District, the largest pig iron producer was the Belgian Company of Tamboff, with 115,400 tons of pig iron per year. The open hearth steel was produced by four plants, their shares ranging from 48,000 tons (Viksa Company) to 69,400 (Googon) Moscow. The Bessemer steel was made in the Sormovo Works, near Nizny-Novgorod. This plant and Kolomensky Locomotive Works of Moscow, also turned out 10,700 tons of high grade steel castings, not included in the tonnages of our summary table. It was at the Moscow plant—Googon—that the first tinplate mill in Russia was installed 20 years ago. The five open hearth furnaces at that mill are fired with crude oil. The Viksa Company, in the Government of Nizny-Novgorod, was a German concern. Its chief product was merchant bars and certain special products.

Group No. 4, or the so-called Southern group, forms the backbone of the Russian iron and steel industry, producing about 75 per cent of the total output of pig iron, 60 per cent of all the open hearth steel and 94 per cent of the Bessemer ingots.

The aforementioned tonnage was produced by about fifteen companies. The blast furnaces belonging to this group consumed 3,680,000 tons of coke in producing the 3,100,200 tons of pig iron, ferro-manganese, spigol, ferro-silicon and so forth.

As the whole of the coke output of the Donetzky District was about 4,500,000 tons there remained 800,000 tons of coke for the furnaces of group No. 3 and the foundry works of Petrograd, Moscow and elsewhere. The blast furnaces of Kertz Peninsula were running on English coke, which necessarily increased transportation difficulties. One of the most up-to-date plants is that of Briansky at Ekaterinoslav, with six blast furnaces having a total capacity of 2,400 tons a day, with bucket charging system designed and built by Nikolai Nikolay Gogozky, general superintendent of this plant. Six gas blowing engines supply the

necessary blast, with four steam blowing engines in reserve. Electric current, 3-phase 3,100 volts, is generated by Curtis steam turbines, fed by boilers fired with clean blast furnace gas. The total output of five generators is 150,000 kw, of which 10 per cent is transformed into direct current. All the rolling mills, except blooming and rail mills, are driven by electric motors. The latter are still driven by reversible steam engines 4,000 and 5,000 hp respectively.

The Bessemer plant includes three converters of 12 tons each, with a 400-ton mixer heated with blast furnace gas. The open hearth consists of 4—30-ton furnaces, 2—40-ton and 1—50-ton, with a mixer of 200 tons. A plant furnishing 10,000,000 slag bricks per annum was completed in 1914.

Among the other plants the most important are Dnieprovsky, Russian-Belgian, Novorossisky, Makeevsky, Drojkovsky, Ktrchensky, Nicopol-Marinpolsky, Donetzky and Lsoolinsky.

THE PRESIDENT'S CONFERENCE ON UNEMPLOYMENT

Recovery of our industry and employment must necessarily be a process of gradual healing of the great economic wounds of the World War. This healing is making distinct progress.

Without attempting the impossible task of assessing the relative weight of different forces, the conference presents the following summary of the more important matters that require constructive and immediate settlement, if recovery in business and permanent employment are to be more expeditiously accomplished.

1. Readjustment of railway rates to a fairer basis of the relative value of commodities, with special consideration of the rates upon primary commodities, at the same time safeguarding the financial stability of the railways.

2. Speedy completion of the tax bill, with its contemplated reduction of taxes, in order that business now held back pending definite determination may proceed.

3. Definite settlement of tariff legislation, in order that business may determine its future conduct and policies.

4. Settlement of the financial relationships between the government and the railways, having in mind the immediate necessity for increased maintenance and betterments, making effective increased railway employment and stimulation of general employment, in order that the railways may be prepared for enlarged business as it comes.

6. Steps looking to the minimizing of fluctuations in exchange, because recovery from the great slump in exports (due to the economic situation in Europe) can not make substantial progress so long as extravagant daily fluctuations continue in foreign exchange, for no merchant can determine the delivery cost of any international shipment.

7. Definite programs of action that will lead to the elimination of waste and more regular employment in seasonal and intermittent industries, notably in the coal industry, in order that the drain upon capital may be lessened and the annual income of workers may be increased.



Boiler Water Treatment Plant

Several Important Methods of Water Treatment Are Considered
—Resultant Operating Tests Are Included Showing the Saving
Brought About.

By ROBERT JUNE, M. E.

PART III

OUR two preceding articles have dealt with the various impurities in boiler feed water, the resultant operating troubles, and we have also considered the use of boiler compounds, boiler metal treatment and water softening plants, as a means of overcoming our difficulties. Several important methods of water treatment have yet to be considered.

Permutit.

All of the troublesome calcium and magnesium in boiler feed water may be removed by passing the water through a bed of zeolite. This is an artificial hydrous silicate produced from clay, felspar, soda ash and pearl ash. A zeolite possesses the valuable property of effecting a rapid exchange of the sodium which it contains for the calcium and magnesium in the water. As hard water is passed through the softening bed the exchange takes place, harmless sodium salts being formed, and the hardness remaining in the zeolite.

The action is a chemical exchange and not a reaction. There is of course a definite limit to the quantity of sodium salts which may be exchanged for the hard calcium and magnesium in the water, this limit depending upon the size of the zeolite bed and the quantity of water passed through it. When the limit has been reached the zeolite bed is regenerated by passing through it a brine composed of common salt. As the reverse of the softening exchange takes place, sodium replaces the destructive minerals and the waste material is carried off to the sewer. The zeolite bed is then ready to treat another batch of hard water. As the exchange involves no loss of the zeolite, the same bed may be used for an indefinite number of years without the addition of a new supply of zeolite.

Permutit is the trade name of a specific form of zeolite, and a specific design of equipment. In the Permutit system the raw water is delivered to the top of a closed tank and is caused to percolate successively through a layer of crushed marble, Permutit and gravel. This filtration effects the necessary purification.

The design of a particular Permutit system will of

course depend upon the chemical composition of the water to be treated and the maximum hourly and total daily amounts. The area of the filter and the depth of the layers must therefore be determined in each individual case, after the water has been analyzed and the desired capacities determined. It is extremely important in connection with the installation of a system of this character to be sure that sufficient allowance is made for all possible contingencies, as the capacity of the system is definitely limited and cannot be exceeded with satisfactory results.

In the main, the rate of filtration through a Permutit bed is as fast as that found in a rapid sand filter, consequently the equipment does not take up a large amount of floor space in relation to the quantity of water handled.

It is the general practice in the design of this equipment to pass the water down through the filter bed. Operating valves are provided so that during the process of regeneration the flow may be reversed, thus thoroughly loosening and carrying upward all exchanged material and sediment deposited in the down flow. By reversing the flow in this manner any tendency of the water to form channels in the filter bed is removed.

When a continuous night and day supply of water is desired, it is necessary to either arrange for the storage of water or for a duplicate set of filters. In regenerating the zeolite bed the water is first drained down to about the upper surface of the Permutit bed. In general a 10 per cent salt solution is employed. This solution is allowed to flow slowly upward through the filter, a number of hours being allowed for the process. In order to cleanse the filter of the salt solution, two or three gallons of water are required for every pound of salt. The outlet cock at the bottom is opened and the filter filled with fresh water. About twenty or thirty minutes are usually required to remove the salt solution, the washing lasting until the water no longer shows any hardness when tested with standard soap solution, as described in one of our preceding articles.

Because of its positive character, Permutit offers a real solution to the feed water problem. Boilers and auxiliary apparatus are found to be maintained permanently clean when water which has been treated by this process is utilized. The initial investment in equipment of this sort is of course a factor which is to be considered. However in view of the large amount of capital necessarily tied up in boilers and auxiliaries, it is well worth while to consider the use of a zeolite system under difficult water conditions.

Borromite.

Zeolite may be classed as slow-acting or rapid-rate. Borromite, a specific trade name of another zeolite softening process is of the rapid-rate type.

The difference between a slow-acting or rapid-rate zeolite may be illustrated by the following example: The slow-acting zeolite softener may have a total capacity of 1,000 gallons. The time required to realize this capacity is from 10 to 12 hours, and the rate at which this capacity of soft water can be realized is uniform and may not be exceeded. In other words, the normal, maximum rate per hour cannot exceed 100 gallons, or one-tenth of the total capacity.

The rapid-rate zeolite, having a capacity of 1,000 gallons, may deliver this quantity of water in as short a period as 1¼ hours. The rate at which the water may be delivered is not restricted by the element of time which enters into the reaction which takes place with the slow-acting zeolite.

Zeolite Plants from an Investment Standpoint.

The figures in Table I have been tabulated for a small steam plant operating three 200-hp boilers, average load 500 bhp., peak load 750 bhp. Make-up amounts to 50 per cent of the total boiler feed. This data is from average figures based on the experience of Borromite users.

TABLE I.

(Coal at \$5.00 per ton in the firebox.)

Cost of Operation with Scale.

- | | |
|---|------------|
| (1) Make-up water is 12 grains per gallon in hardness. Scale in 3 weeks is 7/64 in. thick—average about 1/16 in.; loss in heat is 10 per cent. Boilers opened for cleaning and inspection every 3 weeks. | |
| (2) One of the 3 200-hp boilers is cleaned each week. Labor cost—2 men, 2 days at \$5 per day, per annum..... | \$1,040.00 |
| (3) Coal for heating the water drained out of boiler and that to fill boiler after cleaning—¼ tons × 52 weeks × \$5 (13 tons) per annum..... | 65.00 |
| (4) Investment in a Boiler and Stoker—\$5,000.00. Since a boiler is out of service 2 days each time it is cleaned, this means with 3 boilers there are 104 days one is out of use in a year. (\$5,000 × 7% × 104) ÷ 365 = interest loss on investment | 99.00 |
| (5) Excess blow-down over normal, to eliminate sludge from use of boiler compound, and hard water is 2 gauges extra per day or 310 gallons total for three boilers. (310 gal. × 8.3 lbs. = 210° [rise in temperature] × 365 days × \$5.00) ÷ (8,400 [Btu per lb. of coal] × 2,000 lbs.) = ... | 58.70 |
| (6) New tubes, 12 per boiler or 36 at \$10.00 per annum | 360.00 |

- | | |
|--|------------|
| (7) Coal, 1,400 tons at \$5.00—per annum.... | 7,000.00 |
| Total..... | \$8,622.70 |

Summary:

Cost of operation with scale...	\$8,622.70
Cost of scale-less operation.....	6,416.50
Gross annual saving.....	\$2,206.20
Cost of Borromite Softener for plant of this size—\$3,000.00.	
Interest and depreciation at 15 per cent	\$450.00
Cost of operation, 26 tons salt at \$10.00	260.00
	710.00

TABLE I.

(Coal at \$5.00 per ton in the firebox)
Cost of Scale-Less Operation with a Borromite Water Softener.

- | | |
|---|------------|
| (1) Make-up water is 0 grains per gallon in hardness. No scale is formed. Boilers opened for inspection once every 12 weeks. | |
| (2) No scale, no labor cost for cleaning—per annum | \$ 00.00 |
| (3) Coal for heating the water drained out of boiler and that to fill after inspection. ¼ ton × 12 months × \$5.00 (3 tons) per annum | 15.00 |
| (4) Investment in a Boiler and Stoker—\$5,000.00. Since a boiler is out of service 1 day each time it is inspected, this means with 3 boilers there are 12 days one is out of use in a year (\$5,000 × 7% × 12) ÷ 365 = interest loss on investment | 11.50 |
| (5) No excess blow-down with clean soft water | 00.00 |
| (6) New tubes, 3 per boiler or 9 at \$10.00—per annum | 90.00 |
| (7) Coal, 1,400 tons—10 per cent (140 tons) or 1,260 at \$5.00..... | 6,300.00 |
| Total..... | \$6,416.50 |

Summary (Continued):

Gross annual saving	\$2,206.20
Less interest and operating charges.....	710.00
Annual "Pay-Balance," Net.....	\$1,496.20
Return on investment in Softener.....	50%

Distilling Plants and Evaporators.

Distilled water for boiler feed is in successful use in many power plants. It is first produced by vaporizing the raw water in an evaporator, and then passing the steam to a condenser, or preferably into the boiler feed heater, where it is condensed by means of the feed water entering from the main power plant condenser.

The Reilly Submerged Type Evaporator, consists, essentially, of a closed shell for holding the raw water, into which are introduced a number of steam coils. Live steam from the boiler, sometimes at reduced pressure, or auxiliary exhaust steam, is passed into the coils where, upon condensation, it gives up its latent heat to the raw water, thus vaporizing the raw water.

In order to effect greater economies in operation "double effect" distilling plants are frequently used.

In this type of plant steam from the "first effect" evaporator is condensed in the heating coils of the "second effect" evaporator, the vapor from the "second effect" evaporator being condensed in the usual way.

As a matter of general practice it will be found that the production of the "single effect" distilling plant is approximately one pound of distilled water for one and two-tenths pounds of steam supplied to the evaporator coils, whereas the "double effect" distilling plant will produce about one pound for each seven-tenths pounds of steam supplied to the "first effect" evaporator coils.

Therefore, in choosing between the "single effect" evaporator and the "double or multiple effect" evaporator, consideration is to be given to first cost on the one hand, and to the economies effected by the use of the compound equipment on the other. From a dollars and cents standpoint it is usually more economical and better engineering practice to use the "double" or "multiple effect" system.

Evaporating plants are generally designated as "low heat" level or "high heat" level. In the "low heat" level plant the evaporators may be operated with boiler steam at full or reduced pressure, or with auxiliary exhaust steam at a pressure as low as two pounds. The latter installation, where auxiliary exhaust steam is used, is apt to be quite expensive however, owing to the large volume of steam handled and to the fact that evaporation must take place under a vacuum, thus requiring vacuum pumps, etc.

Where there is say 10 per cent or more of make up water required and where economizers are not used, it will generally be found that the "high heat" level evaporating system is the most satisfactory and economical. As the name indicates, evaporation in this system takes place at comparatively high temperatures and pressures. As the steam consequently passes from the evaporator at high temperatures it can be condensed in a condenser, using circulating water at correspondingly high temperature.

In the Griscom-Russell Company "high heat" level condenser the boiler feed is pumped from the boiler feed heater through the "high heat" level condenser or condensers, on its way to the boilers. Drains from the "high heat" level condenser and from evaporator coils are passed to the boiler feed heater. With this system the boiler feed water re-absorbs all heat given up in the evaporating coils with the exception of the small amount lost in radiation and the evaporator blow off.

Distilled water is of course of zero hardness and its use assures the absolute elimination of any impurities in the feed water, so that exceedingly high boiler ratings can readily be obtained and consistently maintained by the use of distilled feed water.

The analysis in Table II. of probable savings in plant operation by the use of the evaporator system is based on figures supplied by the Griscom Russell Company.

TABLE II.

Net hourly boiler evaporation.....	150,000 lbs.
Net hourly boiler feed make-up.....	15,000 lbs.
Net hourly boiler blow (without evaporator system)	7,500 lbs.
Boiler steam at 200 lbs. gauge, saturated.	
Hot well temperature.....	90° F.
Raw water which would be used for evaporator feed	63° F. (Brackish)

Auxiliary exhaust steam, 13,500 lbs. per hr. at 0 lbs. g.

Boiler evaporation, 9 lbs. of steam to 200 lbs. g. per lb. of coal (Useful heat per lb. of coal = 10,513 Btu).

Cost of coal.....\$4.00 per 2,000 lbs.

Cost of present make-up water \$1.00 per 1,000 cu. ft. (Purchased from Public Water Works)

63°

Boiler Blow—

Will be practically eliminated.

Savings per year =

$$\frac{7,500 \times 330 \times 8,760 \times \$4.00}{10,513 \times 2,000} = \$ 4,124.00$$

Boiler Tube Heat Transfer—

Will be increased sufficiently to save approximately 5 per cent of coal bill.

Saving per year =

$$\frac{150,000 \times 8,760 \times .05 \times \$4.00}{9 \times 2,000} = 14,600.00$$

Boiler Take Down—

Will be largely eliminated.

Estimated saving per year..... 1,000.00

Boiler Maintenance—

Tube replacements, etc., will be greatly reduced.

Estimated saving per year..... 500.00

Cost of Present Make-up Water—

Will be eliminated.

Saving per year =

$$\frac{15,000 \times 8,760 \times \$1.00}{62.5 \times 1,000} = 2,100.00$$

Total yearly savings in plant operation = 22,324.00

CHARGES AGAINST EVAPORATOR SYSTEM.**First Cost—**

Approximate total cost of Evaporator System, including piping, lagging and erection

\$ 26,900.00

Radiation—

Approximate total radiation surface = 800 sq. ft.

Assuming radiation = 60 Btu per sq. ft. per hr.

Heat losses per hour = $800 \times 60 = 48,000$ Btu.

Evaporator Blow—

With the system proposed, evaporator blow will be about 2,500 lbs. per hour at 212° F. (Temp. of raw feed 63°).

Heat losses per hour = $2,500 \times 149 = 373,500$ Btu.

Total heat losses per hour = 421,500 Btu.

$$\frac{421,500 \times 8,760 \times \$4.00}{10,513 \times 2,000} = 703.00$$

15 per cent per year on \$26,900..... = 4,035.00

Yearly labor charges for evaporator system

1,000.00

Total yearly charges against evaporator system

\$ 5,738.00

Conclusions—

Total savings in plant operation per year \$22,324.00

Total charges against evaporator system per year

5,738.00

Net yearly balance..... \$16,586.00

Meeting of the American Electro Chemical Society

Report of the General Meeting Held at Lake Placid, N. Y., September 29 to October 1, 1921—Papers of Interest to the Iron and Steel Industry Presented.

THE general meeting of the American Electro Chemical Society, recently held at Lake Placid, Adirondack Mountains, was considered by all those present to have been one of the most enjoyable of any of the meetings held by that society. The mornings of the days of the convention were devoted to the reading of technical papers while the afternoons were spent in a social way.

During the course of the meeting, a number of papers of interest to the iron and steel industry were presented. Abstracts of some of the most interesting follow:

"Recent Developments in Electric Furnaces of the Muffled Arc Type." H. A. Winne. Several types of muffled arc melting furnaces are described with their features and adaptabilities.

"Electric Furnace Purification of Zirkite." J. G. Thompson. The arc type furnace used in this investigation made it possible to remove 90-95 per cent Si as an impurity from the Zirkite ore; the amount of carbon introduced being only sufficient to transform the silicon to the carbide.

"Physical Characteristics of Specialized Refractories. Cross Breaking Strength at 20° and 1350° C." M. L. Hartman and W. A. Koehler. The tests were carried out on each of 10 refractory materials at the temperatures indicated.

"The Influence of the Electric Furnace on the Metallurgy of Non-Ferrous Metals." H. M. St. John. The use of the electric furnace in brass foundries and refining plants for melting purposes has revolutionized metal handling methods; a more uniform quality of product is obtained with less labor and less metal wastage. The attainments are better than have been previously possible and the secretiveness which has been characteristic of the non-ferrous industry is gradually being done away with.

"Modern Developments in the British Brass Industry." E. H. Smith. The actual conditions of the British brass industry are presented with a discussion of electric brass furnaces, hot pressing and forging of brass, rolling mill practice, annealing, etc.

"Resistance Type of Electric Furnace in the Melting of Brass and Other Non-Ferrous Metals." T. F. Bailey. The various features to be considered in making an electric furnace installation for melting non-ferrous metals are discussed.

"Comparison of Electric Furnace Practice with Fuel Fired Furnace Practice." N. K. B. Patch. The author's experiences are that the cost of metal melted, the melting losses, and the solution of gases in metal, are substantially the same in the electric and the fuel fired furnace, provided intelligent operation is pursued.

"A New Theory of the Corrosion of Iron." J. New-

ton Friend. An auto-colloidal catalytic theory, which postulates the corrosion as starting by the formation of colloidal ferrous hydroxide. This by contact with the air forms hydrated ferric hydroxide which in turn is alternately reduced by contact with iron and oxidized by contact with air, thus continuing the corrosion.

"Rust Prevention by Slushing." Haakon Styri. An extended research which shows that for protection against rust by greases a thorough cleaning of the steel parts by an aqueous solution is essential; an oil emulsion which leaves an oil film for short time protection is preferable. Such emulsions protect against rust.

"Transformer Oil Sludge." C. J. Rodman. Of the three types of transformer oil sludge (asphaltic, soap and carbon), the asphaltic is the most general form and is the oxidation product of an attackable oil. It collects upon the active parts of transformer. The soap sludge forms slowly and is difficult to remove by filtration. The carbon sludge is caused by electrical breakdown.

"An Electric Steam-Generator for Low Voltage." F. A. Lidbury and F. A. Stamps. An inexpensive form of apparatus for the generation of steam by means of an alternating current of voltages from 100 to 500.

"The Effect of Pressure on Overvoltage." H. M. Goodwin and L. A. Wilson. The values of overvoltage of hydrogen against copper, nickel and mercury electrodes were determined at pressures varying from one atmosphere to a few centimeters of mercury.

"Researches on the Electrodeposition of Iron." W. E. Hughes. The results of several experimenters and those obtained by the author are related in three electrodeposition of iron from (1) sulphate solutions, (2) chloride solutions and (3) sulphate-chloride solutions.

STEEL FOUNDRYMEN APPROVE CO-OPERATIVE PLAN

Officers and operating heads of five steel casting companies which have been associated in research work to which Major R. A. Bull, Sewickley, Pa., devotes all of his time for the benefit of the co-operating companies, recently held a meeting at Wernersville, Pa. The companies which specialize in the manufacture of small steel castings and which were represented at this meeting include the Lebanon Steel Foundry, Lebanon, Pa.; Fort Pitt Steel Castings Co., McKeesport, Pa.; Michigan Steel Castings Co., Detroit; Electric Steel Co., Chicago, and the Sivyer Steel Castings Co., Milwaukee. At the beginning of their co-operative work these companies established uniform standards of inspection and after a years' experience in adhering to these standards unanimous approval was expressed at this meeting concerning this method of obtaining a uniform and satisfactory product.

PRODUCTION TOPICS

OUTLINE OF A PRACTICAL COURSE IN STEEL MAKING.

By P. S. Young.

(Continued from October issue)

In making out these papers they should be able to call on the help of the man who has been overseeing the work in that department. He will doubtless be able to clear up some very necessary points which they have overlooked or not thoroughly understood, thus giving them a comprehensive view of the main workings of the department. This paper should be written in three days time or less, and while writing it the men should do nothing else.

During their course, if any experimental work is being done or tests made, they should be present to witness it or take an actual part in it.

Item 4. Contract between the student and company.

If the proper selection has been made, and a man has gone through the course successfully, he should be assured of a good wage, as he is now in mental and physical condition to do many jobs well. He should be consulted as to the department in which he prefers to work, and the first opening in keeping with his knowledge and experience should be given him. If the management does not feel he is capable of it, the selection for the course was undoubtedly bad, and should have been discovered long before. If he does not show sufficient executive ability when given the opportunity of handling men, his ability to have stood through the course and his experience in the steel works should fit him splendidly for the sales or purchasing departments.

During the course he should be graded on the following points:

1. Ability (general).
2. Adaptability.
3. Perseverance.
4. Willingness to work.
5. His relations with fellow-workmen.
6. Habits (proper).
7. Habits as to regularity and punctuality.
8. Examination grades.
9. Final examination in each department.
10. Thesis on each department.

The following is a trial outline of the course:

Blast Furnaces. (30 weeks)

Car dumper and larry cars	1 week
Ore bridge and skip hoists	1 week
Stock cars under trestle in stock house.....	1 week
General work around stock house, going rounds with S. H. Foreman	1 week
Pipe fitting gang at blast furnaces.....	2 weeks
Labor gang at furnaces (cleaning stoves, scrapping runners, snapping cinder, unloading scrap, wheeling tools, changing tuyeres and all repair work)	1 week
Helper on furnace	1 week
Keeper on furnace	3 weeks
Hotblastman (stoveman)	3 weeks
Watching blower	1 week
As blower (not in actual charge of furnace, but making all the decisions and being told by blower where wrong)	2 weeks
With turn foreman (going around with him in all his work)	1 week
At gas plant working around gas scrubbers, separators and washers	3 weeks

In blowing rooms	2 weeks
At pig machine. (If pig machine is not in regular operation, six of its operating days may be picked while student is in blast furnace dept....	1 week
On blast furnace, bricklayers gang doing brick repairs around the furnaces and studying their prints of blast furnace lining and construction of stoves	4 weeks
In blast furnace office with clerk making out log book reports, all other reports and burden sheets. Last three days of this time writing thesis	2 weeks
Total.....	30 weeks

Open Hearth Department (35 weeks)

Stock yard as stocker	2 weeks
Weigh offices	1 week
Ladle liner helper	3 days
Nozzle setter helper	3 days
Stopper setter helper	1 week
Third helper on furnaces	3 weeks
Second helper on furnaces	4 weeks
With first helper (as with blower at blast furnaces)	4 weeks
Following melter foreman all day	1 week
Steel pouring gang	4 weeks
Open hearth bricklayer gang	8 weeks
Gas producers (if natural or by-product gas, oil or tar is used, time at producers should be distributed between floor and pouring platform)....	3 weeks
Mixing house pans and crushers	1 week
Calcing cupolas	3 days
Open hearth office (making reports, general office work)	1 week
Writing thesis	3 days
Total.....	35 weeks

Bessemer Department (6 weeks)

If there is no Bessemer department distribute this time between the open hearth floor and platform work	1 week
Metal mixer	1 week
Vessel gang	2 weeks
With regulator in blowers pulpit.....	1 week
As regulator	1 week
Total.....	6 weeks

Blooming Mill Department (18 weeks)

Blooming mill office (learning to make out tonnage reports, dealing with orders coming in and orders filled and how orders are booked and distributed)	1 week
Steel distributor to the different pits.....	1 week
Soaking pits as bottom maker's helper.....	1 week
With heater	3 weeks
Mill recorder's office	1 week
Roller's pulpit	3 weeks
Billet mills on stands and shears.....	3 weeks
Bricklayer gang on soaking pits	3 weeks
Roll shop	3 week
Office and writing thesis	1 week
Total.....	18 weeks

Finishing Mills Department (14 weeks)

(There is such a diversity of finishing mills that this section of the course should be made out by the department head where the above course designed for rod mills falls short.)

NEWS OF THE PLANTS

The Harrisburg Bar Mill Company, Harrisburg, Pa., recently organized with a capital of \$50,000, will operate a plant on North Sixth Street, near the city limits, for the manufacture of steel and iron bars. The rolling mill has been producing for several weeks past, running on a single shift, and as soon as conditions warrant a night force will be employed. The plant equipment comprises three oil-heating furnaces, a 12-inch merchant mill and a 9-inch merchant mill with auxiliary operating machinery. Employment will be given to about 100 men for the present. J. K. White, formerly general sales manager of the Harrisburg Pipe & Pipe Bending Company, Harrisburg, is president of the new organization, and A. L. Ensinger, also previously connected with the same company, is secretary.

The Keystone Iron & Steel Works, Los Angeles, Cal., has commenced operations at its new plant at 2931-3641 Santa Fe Avenue, comprising two main buildings, three, two and one-story in height. The company will make a specialty of steel and gray iron castings, and has installed a complete electric steel furnace department for this purpose. Other products will include a number of iron specialties and for which complete facilities have been installed.

The Columbus Forge & Iron Company, foot of West First Avenue, Columbus, Ohio, manufacturer of forgings, anvils, etc., has awarded a building contract to the Middle States Construction Company, Nock Road, for the construction of its proposed new plant additions for increased capacity. The structures will be each one-story, 70x200 feet and 100x160 feet, respectively. Foster Copeland is president.

The Richard French Iron Works, Muskego Street, Worcester, Mass., recently reorganized, will commence the immediate construction of its proposed new plant on property lately purchased at Millbury, Mass. The works will consist of a main one-story building, 65x120 feet, with a number of smaller structures averaging 25x25 feet, for general iron-working and office service. Local electric power will be used, and the company will install motors and other electrical apparatus for operation. The building contract has been awarded to the E. D. Ward Company, 82 Foster Street, Worcester. A. B. Campbell is president and Raymond Tracy vice president.

Horace T. Potts & Company, 316 North Third Street, Philadelphia, Pa., iron and steel products, has awarded a building contract to William Steele & Sons, Inc., Sixteenth and Arch Streets, for the construction of a new plant at Erie and D Streets, consisting of a number of buildings, estimated to cost about \$450,000, including equipment. Erection will be placed under way at an early date.

The Tomahawk Steel & Iron Works, Tomahawk, Wis., has foundation work under way for its proposed new two and three-story plant to replace its works recently destroyed by fire. A list of equipment for installation has been prepared, including traveling cranes, iron working machinery, machine tools and other apparatus. The new plant is estimated to cost close to \$100,000, as compared with a previous estimate of \$80,000. It will be 100x180 feet. W. Drever is president.

The Utah Iron & Steel Company, Salt Lake City, Utah, manufacturer of steel bars and other steel and iron products, is arranging an extensive expansion program at its works at Mid-

vale, Utah. A new blast furnace will be constructed, with a number of new mills, including plate mill, bar mill, rolling mill and other structures. New shops for general production, machine work, etc., will be erected. The entire project is estimated to cost close to \$3,000,000, and to carry out the details of the work the stockholders have voted to increase the capital from \$2,500,000 to \$5,000,000, with the addition of 50,000 shares of common stock, no par value.

The Driver-Harris Company, Middlesex Street, Harrison, N. J., manufacturer of wire, steel products, etc., will commence the immediate erection of a new one-story plant building on Somerset Street, between Third and Fourth Streets, to be equipped as a rolling mill. It will be 95x275 feet, and is estimated to cost about \$35,000.

The Electric Manganese Company, Reading, Pa., care of William H. Dechant & Son, Baer Building, Reading, has plans under way for the construction of a new one-story plant in the Brush Valley Section, and plans to inaugurate work at an early date. The structure will be 40x140 feet, and is estimated to cost close to \$55,000.

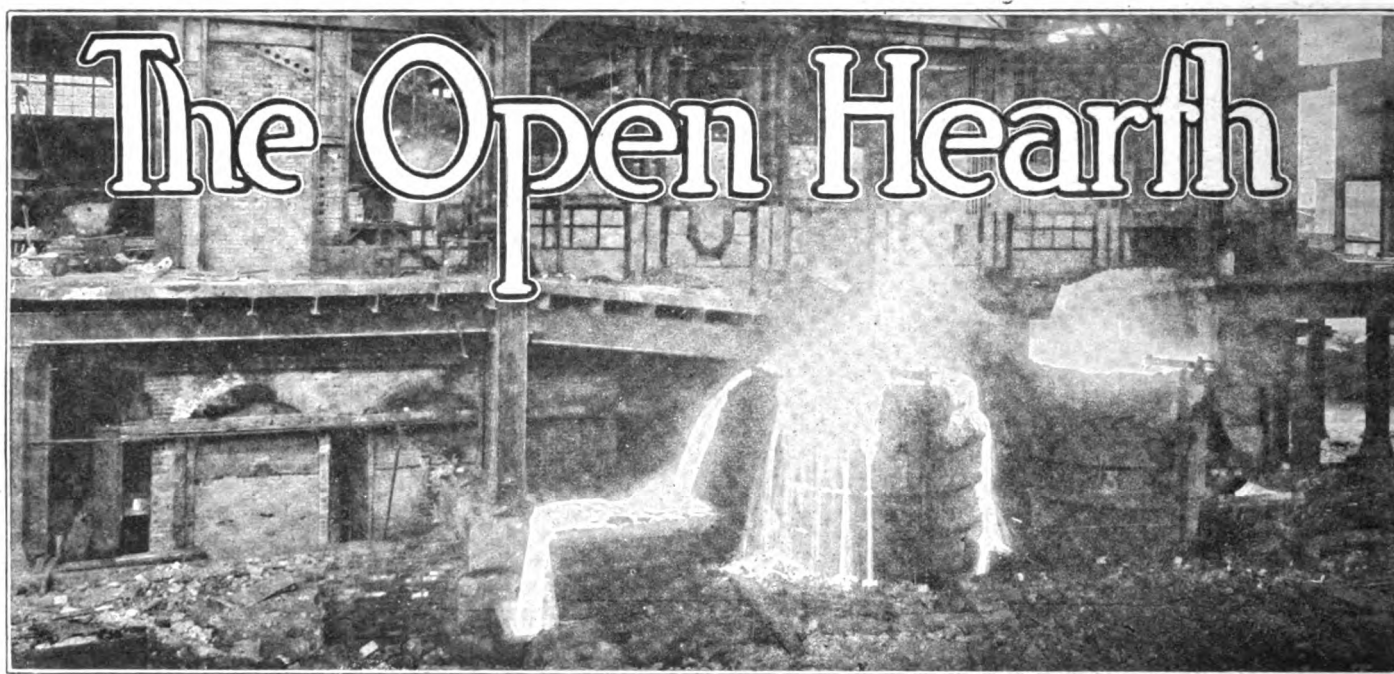
The Wyckoff Drawn Steel Company, Frick Building, Pittsburgh, Pa., has awarded a contract to the American Bridge Company, Pittsburgh, for the structural steel for the superstructure of its proposed new one-story plant at Wyckoff, near Ambridge, Pa. It will be 60x250 feet, and is estimated to cost approximately \$75,000. It is proposed to have the structure ready for service early in the coming year.

The Southern Coal & Iron Corporation has acquired the plant and property of the Rittenhouse Iron Company, Rittenhouse Gap, near Mertztown, Pa., in the Lehigh iron district of the state. The new owner will place the works in immediate operation for the production of iron products to be used by various interests in this same section, including the Bethlehem Steel Company and the Eastern Steel Company, for blast furnace work. The properties are estimated to contain about 700,000 tons of proven iron ore and approximately 5,000,000 tons of potential iron ore, containing over 50 per cent iron and which will be concentrated at the plant to a 65 per cent iron basis.

The Beloit Iron Works, Beloit, Wis., has preliminary plans under way for the construction of an addition to its plant for increased production. The structure will be one-story, 65x85 feet, and is estimated to cost close to \$55,000, including equipment. E. H. Neese is vice president of the company.

The Virginia Shipbuilding Company, Alexandria, Va., is reported to be planning for the immediate rebuilding of its steel fabricating plant, recently destroyed by fire with loss estimated at close to \$125,000, including machinery. The plant is located on the Potomac River.

The General Iron Works Company, 1720 California Street, Denver, Colo., has preliminary plans under way for the construction of a new one-story building, to be located at Blake and Thirty-third streets. The structure will be supplemented by a number of smaller buildings. The new plant is estimated to cost about \$100,000, including equipment. Bids for erection will be asked at an early date.



F. E. Stapleford was elected president of the Cincinnati Association of Purchasing Agents at the annual meeting on September 22. J. C. Kreis was elected vice president; G. C. Merkel, treasurer, and E. W. Simpkinson, secretary. The entire membership, numbering 80, attended the convention of the National Association at Indianapolis.

V V

Robert McKean, general manager Riter-Conley Company, Pittsburgh, returned recently, after an absence of two a half years in France, to this country. Mr. McKean had charge of the European interests of his own company and the McClintic-Marshall Co., an affiliated company.

V V

James A. Campbell, president of the Youngstown Sheet & Tube Company, is among those who have accepted invitations to participate in the unemployment conference which recently opened in Washington. Among the acceptances were those of John D. Ryan of the United Metals Selling Company; M. F. Tighe, president of the Amalgamated Association of Iron, Steel and Tin Workers, and John A. Penton, secretary American Pig Iron Association.

V V

A. J. Billimoria, Bombay, India, head of the firm of managing agents of the Tata Iron & Steel Company of the various other Tata interests, is now in New York on business with Perin & Marshall, consulting engineers. He returned to London in October and later will proceed to India.

V V

Richard Jones, Jr., is recovering from an operation which he recently underwent in the Youngstown City Hospital. Mr. Jones is general counsel for the Republic Iron & Steel Company, Youngstown, Ohio.

V V

H. W. Bishop, Jr., was recently made sales manager of the Superior Pipe Company, Columbia, Pa. Mr. Bishop was formerly in the general sales department of the La Belle Iron Works, Steubenville, Ohio.

V V

David P. Hopkins, general works manager of the United States Cast Iron Pipe & Foundry Co., Burlington, N. J., is traveling in Europe to investigate conditions in the European iron and steel business with special reference to the manufacture of cast iron pipe. Mr. Hopkins attended the joint meeting of

the British Iron and Steel Institute and the Comité des Forges in Paris and Lorraine.

V V

Edward M. Huggins was recently promoted to the position of chief engineer of Sneed & Company, Jersey City, N. J. Mr. Huggins was formerly assistant chief engineer. He was graduated from Lehigh University in 1900 with the degree of mechanical engineer and has been with the Sneed Company since 1913. Prior to that he was with the E. H. Munford Company, maker of foundry molding machinery, for seven years, serving in various capacities, including that of chief engineer.

V V

Walter S. Tower, recently named as the first chief of the iron and steel industrial division of the Bureau of Foreign and Domestic Commerce, has been appointed commercial attaché of the bureau at London and sailed October 7 from New York to take up his new duties. He succeeds Alfred P. Dennis as commercial attaché, Mr. Dennis having been named to make an investigation of agricultural conditions in Europe. Mr. Tower has been succeeded as head of the iron and steel division by Luther Becker, Montclair, N. J., who now is serving as acting chief of the division.

V V

W. F. Abel, who for 13 years was in charge of sales for the Halcomb Steel Company, has been appointed assistant general manager of sales of the Electric Alloy Steel Company, Youngstown, Ohio.

V V

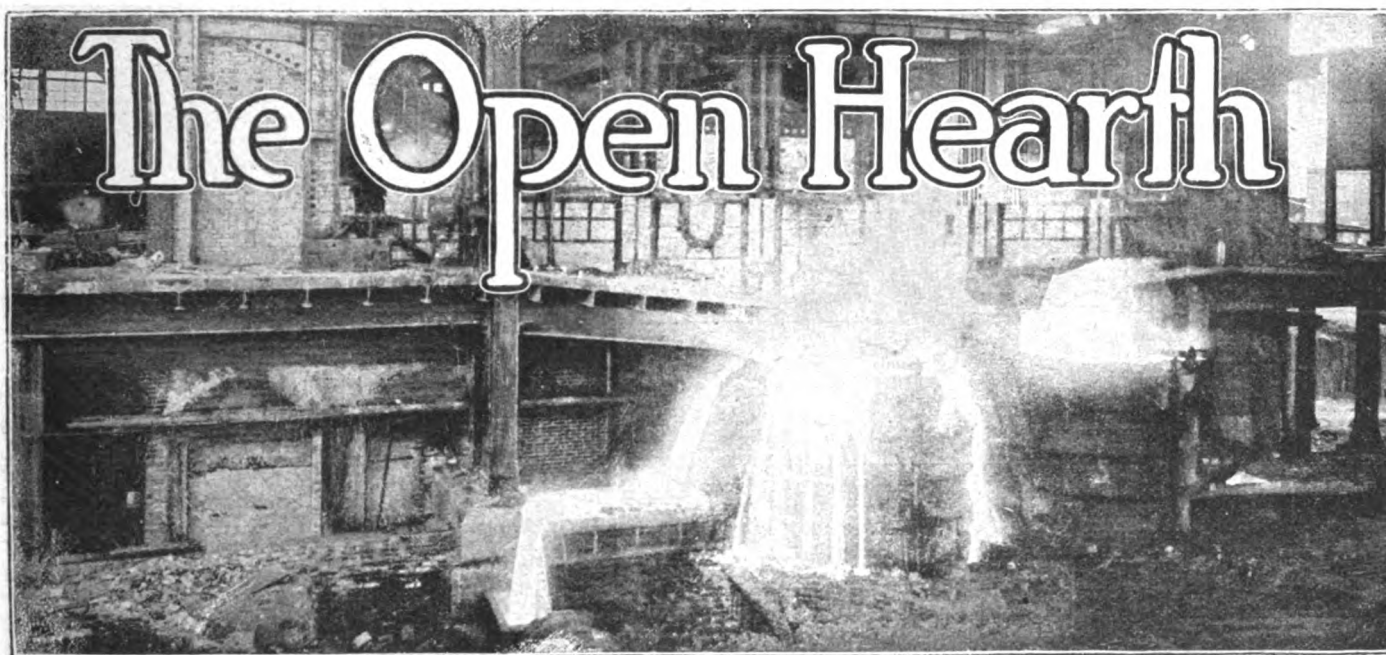
H. O. Davidson has severed his connection with the Hydraulic Steelcraft Company as general manager to become general manager in Baltimore of the C. D. Pruden plant of the Blaw-Knox Company, Pittsburgh.

V V

J. M. Ross, auditor of Wheeling Steel Corporation since its formation, recently was elected secretary of the corporation, succeeding G. W. Hocking, who resigned early in August. Prior to joining the Wheeling Steel Corporation, Mr. Ross was identified with Price, Waterhouse & Co., and gained considerable familiarity with the steel business through auditing the accounts of steel companies. He will act for the present as both secretary and auditor.

V V

Col. Henry P. Bope, New York, former first vice president of



the Carnegie Steel Company, Pittsburgh, of which company he also was general sales manager, has been elected a director of the International Sheet Tube Company, Cleveland. It is understood Col. Bope, in addition to being a director, will hold an executive position with the company, possibly president, although announcement to this effect has not been made. The International Sheet Tube Company has a tube plant under construction at Cleveland.

V V

H. P. Parrock recently resigned as general manager of the Lumen Bearing Company's plants at Buffalo, N. Y., and Youngstown, Ohio, but remains on the Youngstown directorate. He will engage in professional work at present at 164 Lancaster Avenue, Buffalo, covering the design and construction, but more particularly the active operation of foundries, specializing in brass foundry work. His connection with the Lumen Bearing Company began in 1910, and he served at different times as sales manager, manager and general manager. For two years after graduating in 1901 from the Massachusetts Institute of Technology he served as assistant superintendent of the rolling department of the Pennsylvania Steel Company, and from 1904 to 1990 was superintendent of the steel foundry of the Youngstown Foundry & Machine Company.

V V

E. E. Barto was recently appointed production manager of the Warren Iron & Steel Company, Warren, Ohio. Mr. Barto, for the past three years, has been connected with the Indiana Rolling Mill Co., Newcastle, Ind., in the capacity of production manager. Fifteen years previous to that, Mr. Barto was connected with the Jessop Steel Company, Washington, Pa., as rolling mill superintendent. He has had experience in rolling high carbon and alloy open-hearth, electric furnace, and crucible steels.

V V

Henry B. Barnhart, 59, superintendent of the open hearth department of the Brier Hill Steel Company, Youngstown, Ohio, died on the evening of October 3 from paralysis. Mr. Barnhart had been identified with the Brier Hill Steel Company for the past five years, after resigning as department superintendent of the Illinois Steel Company, Chicago, where he had served for eight years.

V V

J. L. Neely has been promoted to the position of traffic manager, in place of the late Andrew G. Young, of the American Sheet and Tin Plate Company. Mr. Neely was, for the

past eight years, assistant traffic manager and has been connected with this department for the past twenty years.

V V

John F. Miller of Pittsburgh, Pa., vice president of the Westinghouse Air Brake Company, Pittsburgh, has been elected an alumni trustee of the College of Wooster, Wooster, Ohio, filling an unexpired term in the class of 1922. Mr. Miller was graduated from the college in 1881.

V V

William Whistler Mills, for five years assistant chief chemist of the Pittsburgh Crucible Steel Co., Pittsburgh, Pa., at its Midland, Pa., works, has been added to the faculty of the College of Wooster, Wooster, Ohio, as an instructor in chemistry. Mr. Mills resigned from the Pittsburgh Crucible Steel Company in 1919 to take up graduate work in Ohio State University, Columbus, Ohio, which he completed last June with the degree of Master of Science.

V V

Frank R. Huston has been appointed general superintendent, in place of A. W. Courtney who has resigned, of the Donner Steel Company, Buffalo, N. Y. Mr. Huston was formerly chief auditor and has been with the company since its organization, going there from the Cambria Steel Company, Johnstown, Pa.

V V

Edward Ray Weidlein, acting director of the Mellon Institute of Industrial Research, University of Pittsburgh, has been appointed director of the institute. Mr. Weidlein, who has been associate director since 1916, assumed the office of acting director when Dr. Raymond Foss Bacon resigned some time ago to engage in chemical practice in New York. Mr. Weidlein was a student of the late Dr. Robert K. Duncan and later became an industrial fellow of the Mellon institute. He has been associated intimately with the industrial fellowship system since 1909, and since 1916 has been a member of the administrative staff of the Mellon institute. He has had experience in the supervision of industrial research and enjoys a national reputation as a specialist in the systematic investigation of the problems of chemical and physical technology. He was born at Augusta, Kan., July 14, 1867, and was graduated from the University of Kansas with the degree of bachelor of arts in 1909; in 1910 he received the degree of master of arts.

WITH THE EQUIPMENT MANUFACTURERS

A NEW LINE OF HOISTS.

Plant Superintendents will be interested in learning that the Treadwell Engineering Company, Easton, Pa., has placed a new line of hoists, both steam and electric driven, on the market. The Treadwell Engineering Company, while a long established and well known manufacturer of rolling mill equipment, has not, hitherto, been so closely identified with the mining field.

In entering upon the building of its line, the Company states that it has been fortunate in securing the services of Mr. Thos. O. Werner as chief engineer of its hoist department. Mr. Werner is widely known as a hoist expert, having been associated with the S. Flory Manufacturing Company in a similar capacity for many years.

The combination of sound design, and the patented features which are pointed out as distinct improvements, with the vast manufacturing facilities of the Treadwell Works should make the line one which will enjoy marked favor with users of such equipment, both for its mechanical excellence and for the service which the manufacturer is in a position to render.

Among the features which distinguish these new hoists is a double-toggle clutch mechanism which is claimed to be a step forward in design. The clutch is usually mechanically operated by a double acting cylinder, although it can be arranged for hand operation if desired. A point is made of the fact that the clutch (of the hand type) drives directly from the rim of the main gear, which carries the driving portion of the clutch, to the friction flange of the drum. This construction necessarily eliminates any torsional stress in the drum shaft, and end strain or thrust in the bearings or operating mechanism, for when brought into play this device is automatically locked.

Other points of structural excellence, of which mention may be included, are the tongue-and-grooved joints between all sections of the main frame to afford a rigid bolting together, the fact that the motor and intermediate bearings are mounted on a one-piece casting, the very satisfactory provision for lubrication at all bearings, and the entire absence of cast iron in the mechanism of the differential brake or brakes, with which these machines are provided.

The Treadwell Company is building a complete line and is prepared to offer a machine to meet practically any operating conditions within a range of from 100 to 300 horsepower. These hoists can be arranged for either electric motor or steam engine drive.

NEW SWITCH INTRODUCED.

A compact, light weight, quick acting contactor with blowouts and copper to copper rolling contacts is the outstanding feature of the new across-the-line type of starting switch just being placed on the market by the Allen-Bradley Company, Milwaukee, and described completely in a new bulletin J-1552 just issued. This starting switch is for use with small alternating current induction motors that can be connected directly to the supply lines. Automatic control of the motor is obtained when the starting switch is used with a push button, pressure gauge, flat switch, thermostat or any other type of pilot circuit control.

The principle of this switch is not new as the Allen-Bradley Co. has manufactured across-the-line switches for a number

of years, but the design is new and distinctive in the simplicity of the assembly of the switch parts and cabinet. The copper to copper rolling contacts, blowouts and the laminated magnetic circuit are the same design as used on the larger quick-acting magnetic switches, but simplification of the assembly make this switch available for general use as a safety device with all automatic features where formerly the cost made it prohibitive when compared to manual switches.

Complete overload and low voltage protection are offered by the starter when used with standard push button. Failure of the supply voltage or a continuous overload will open the contactor, thus disconnecting the motor. Return of the voltage will not reconnect the motor unless the start button is pressed. Likewise the motor cannot be started after an overload unless the start button is pressed. When used with float switches, or pressure gauges, the starters are furnished with hand reset overload relays to prevent restarting of the motor after an overload has opened the circuit. With these auxiliary controls low voltage release is offered. Return of voltage to normal after temporary suspension will automatically re-connect the motor and insure continued perform-



Fig. 1.

Fig. 2.

ance from the pump, compressor or similar connecting equipment.

The use of magnetic blowouts, together with a light weight contactor which makes and breaks the circuit quickly, practically insures interruption of the circuit even under extreme conditions of overload.

The overload relays are of the inverse time limit dash pot type. They are the same as used for overload protection on all Allen-Bradley starting and current controlling devices and by other manufacturers as part of their standard starting equipment. The Allen-Bradley relays have a unique double seal of the piston in oil, which insures the full time element, yet there is little motion of the piston until the seal breaks, when the piston is released suddenly so that the relay contacts are tripped open quickly and positively.

Some Pointers on By-Product Coke Oven Operations

SOME INFORMATION ON THE PIETTE BY-PRODUCT OVEN.

This oven has been built for many years in several countries in Europe, particularly Belgium and France.

It is not a new oven, but an improved and in every respect modern oven, which has already stood a long test as to yields in coke, gas, by-products and durability in a manner never exceeded. Its very simplicity of construction makes it adaptable to the different conditions of the industries whatever difficulty, and the several designs existing respond each one to a particular requirement of the industry or to a particular kind of coal. With some coals the problem of the designer of the oven is not only of which construction will permit their coking but which will do it economically when both first outlay and operation expenses are considered.

The several designs of Piette ovens built so far are the following:

Combined ovens of waste heat type capable of working without alteration, with or without recovery of by-products.

By-products recovery and waste heat ovens.

By-products ovens with regenerators.

By-products ovens with regenerators arranged for heating with coke oven gas or with heated blast-furnace or producer gas.

Inverted flame type of regenerative by-products coke ovens, with vertical heating flues, designed to make good coke out of certain kind of coals, high in volatile matters but lacking in coking properties.

The following is a description of the demonstration ovens which have been built at the Coke Station of the Laclede Gas Light Company at St. Louis, Missouri, in 1920 and are being operated by said company and are of the by-products type with regenerators.

Their dimensions are:

Height under arch: 9 ft. 10 $\frac{5}{8}$ inches.
Length between doors: 37 ft.
Average width: 19 $\frac{3}{4}$ inches.

This oven is with vertical flues, with regenerators acting transversely and with reversing device. The gas and the air enter in all the flues situated on one side of the inversion axis of the battery, along the coke side for one period of $\frac{1}{2}$ an hour and along the pusher side for the following half hour period. The burnt gases travel downwards through all the flues situated on the other side of the inversion axis.

On the top of each vertical heating flue a regulation section of which the size has been carefully but definitely arranged at the time of the construction, connects the flue with a horizontal chamber (t) above.

On each side of the coke oven wall the gas is sent through four tuyeres to conducts located at the foot and in the axis of the oven wall. These conducts lead to distribution chambers (a) and each room feeds the burners of one set of 3 or 4 heating flues.

Part of the combustion air circulates first in the galleries (g) and (h) where it is heated for the first time before entering the regenerators. The regenerating galleries extend over the whole length of the battery. Each regenerator is com-

posed of 2 galleries located side by side which galleries communicate with each other through numerous openings. One of the galleries contain less checker brick work than its parent gallery, and the free space above said checker work constitutes the air entrance conduct in one period of inversion and the burnt gas collector in the following period.

The flow of the air through the checker brick work, as well as the flow of the burnt gases travels therefore parallel to the axis of the oven and it is only in the free space of the two regenerating galleries that the flow of the gaseous currents travels longitudinally.

The sole-flues (S) connect the regenerators with the foot of the oven-wall.

The connecting channels between the regenerators and the sole-flues are regulated by damper bricks (r).

Air nozzles connect the sole-flues with the heating flues of the ovens. Each part of the oven walls can be inspected through vertical flues existing in the top of the battery and which are closed by plugs.

A rapid control of the heating of each oven wall is facilitated by loopholes located on the front of the oven at the level of the horizontal room (h). Appropriated holes allow a quick inspection of the sole flues.

The color of the regenerators is easily watched through inspection holes situated at each end of the battery.

Results of 30 consecutive days' test of the Piette ovens built in St. Louis, Mo., at the plant of the Laclede Gas Light Company:

Mixture of coal charged:

65 per cent Elkhorn.
35 per cent Pocahontas.

Average analysis of mixtures:

Moisture 4.433%
On dry basis:
Volatile Matter 30.416%
Ashes 5.378%
Fixed Carbon 64.208%

Coking time: 20 Hours, 18 Minutes.

Load per oven: 26,770 Pounds.

Total yield in Coke: 69.19 per cent.

(Coal moisture included and dry coke.)

Average analysis of coke:

Moisture 1.936%
On dry basis:
Ashes 6.900%
Fixed Carbon 92.110%
Volatile Matter 0.990%

Total gas produced:

Per pound of coal charged 5.849 cu.ft.
Calorific value of this gas 564.5 Btu.

Yields in By-Products, per Ton of Coal Carbonized:

Ammonia, in pounds 5.632
Tar, in gallons 7.009
Benzol (product distilling below
200 Centigrade in gallons) 3.416

Calorific Balance of a Piette Ovens Battery—Demonstrated in the St. Louis Test:

Btu produced 100 per cent.
Btu in the surplus gas 63.25 per cent.
Btu consumed in the heating gas 36.75 per cent.

TRADE NOTES

Mr. Abner U. Howard has been appointed Sales Manager for N. & G. Taylor Company, Inc., General Offices, 300 Chestnut Street, Philadelphia. Mr. Howard was for many years connected with the National Conduit & Cable Company of New York City and recently with the Stamford Rolling Mill Company of Stamford, Conn., as Sales Manager.

The Blaw-Knox Company wishes to announce the addition to its staff of Mr. H. O. Davidson. Mr. Davidson will have entire charge of the Prudential Sectional Building Department of the Blaw-Knox Company and will be also General Manager of the C. D. Pruden plant of the Blaw-Knox Company. Mr. Davidson will be located at the C. D. Pruden plant at Baltimore. Mr. Davidson was connected for eight years with the Hydraulic Steelcraft Company, being General Manager of that organization at the time he severed his connections to become a member of the Blaw-Knox staff.

The Denk Engineering Company has been incorporated to do business in designing and installing gas plants, furnaces and piping. The offices of the company are in the Shannon Building, 4th Avenue, Pittsburgh, Pa. F. J. Denk is president and consulting engineer.

The Ford Motor Co. have recently placed an order with the Electric Furnace Construction Co., 908 Chestnut Street, Philadelphia, for two large "Greaves-Etchells" Electric Furnaces for their new plant at the Rouge Works, Dearborn, Michigan. The furnaces will be basic lined, and they are designed to operate either for melting up accumulation of scrap or for treating hot metal. This is the third order placed for this type of furnace by the Ford Company, the first unit having been installed at the Highland Park Works in 1917.

Northern Engineering Works report the sale of a 20-ton, 3-motor electric travelling crane to C. W. Marthens Co., Chicago.

Chain Belt Company, Milwaukee, Wisconsin has opened offices at 735 Ellicott Square, Buffalo, N. Y., and have announced the appointment of T. E. Cocker as District Manager of that territory. Mr. Cocker will handle the REX Line including Chain, Sprocket Wheels, REX Traveling Water Screws, Elevators and Conveyors.

TRADE PUBLICATIONS

The Northern Engineering Works have issued a new booklet entitled, "Northern

Cranes In The Foundry." It covers this subject very completely.

Bulletin No. 234—"The Continuous Heat-Treatment of Metals With Automatic and Semi-Automatic Furnaces," has been issued by the W. S. Rockwell Company. This is the fourth of a series dealing with fundamentals that influence quality and cost of heated products. It illustrates practical applications of the principles outlined by the previous bulletins of the series.

A. C. Automatic Starters with Mercury Type Overload Relays, is the subject of a new publication (2038) describing and illustrating this new type of starter designated as Bulletin 9604, made by the Cutler-Hammer Mfg. Co., of Milwaukee. The theory of the new mercury interlock is given and curve included to show how tripping depends upon the time and the percentage of overloading.

Heat Resisting Alloys—The General Alloys Company, New York, has compiled a 28-page booklet describing Q-Alloys. An important feature of this book is the description of their new heat resisting alloy which is sold at 20c per pound.

R. D. Nuttal Company, Pittsburgh, Pa., recently published a 4-page folder entitled "Drop Forged Steel Pinion Blanks," which describes the method of forging and upsetting pinion blanks. This folder gives the results of tests on these forgings and is illustrated with macrophotographs showing the grain structure.

The Box Bulletin—Published by the General Alloys Company, New York, contains several short articles which should be of interest to our readers. The first article is the "Selection of a Carbonizing Compound," by H. B. Knowlton, and the second "The Design of Carbonizing Containers," by George Charlton.

Air Hammers—The Nazel air hammer is very completely described in the recent booklet published by the Nazel Engineering & Machine Works, Philadelphia, Pa. In it the operating principle is discussed. The general construction, motive power and the various types of hammers are taken up in detail.

Furnace Screens—Weigand patented chain furnace screens for furnaces and ovens are described in a small 8-page booklet recently issued by the E. J. Codd Company, Baltimore, Md.

The Selas Company, Philadelphia, Pa., in a 4-page circular discuss economical gas utilization and the adjustments on the Selas machine for securing complete combustion.

Rezistal Steel—In a booklet recently issued by the Crucible Steel Company of America, C. M. Johnson, director of the Research Department, describes this new

steel which is non-magnetic and resists the action of flame, acids and rust. It includes a paper which was presented before several chapters of the American Society for Steel Treating and a number of testimonials from users of this new steel.

The Titanium Alloy Manufacturing Company, Niagara Falls, N. Y., in a leaflet offers the facilities of the Commercial Service Department of the physical, metallurgical and metallographic laboratories to manufacturers and others interested in metallurgical and mechanical lines.

The Robbins Conveying Belt Co. have recently published a Handbook of Conveyor Practice which should prove valuable to engineers and draftsmen having to do with the planning or designing of conveyor installations for whose aid it is intended. Besides describing and illustrating installations of various kinds erected by the above company, the book contains a group of tables governing capacities, power requirements, speeds of conveyors, and similar matter, together with general data on conveyor practice. 96 pages, size 6 x 9, bound in heavy cover.

A bulletin known as their No. 9 Catalog, entitled Pulverized Fuels has just been published by the Hardinge Co., New York, N. Y. The bulletin is divided into three main sections covering, respectively, the application of pulverized fuel as a solution of various combustion problems, the principle of operation of the Hardinge mill, and a discussion of the Hardinge system for pulverizing fuels. The catalog contains in addition to the descriptive matter, many interesting illustrations. Size 8½ x 11, sixteen pages and cover.

Concrete Bins and Pits for Coal Storage is the title of an interesting pamphlet published by the Portland Cement Association. It contains information and illustrations showing why and how coal should be stored. 16 pages, size 6 x 9.

Bulletin No. 232, The Variety of Furnace Design is the third of the series dealing with the fundamentals that influence the quality and cost of heated products, issued by the W. S. Rockwell Co., New York, N. Y. This bulletin illustrates the relation of type and arrangement of heating equipment to cost of production, and the many factors that must be considered in adapting such equipment to individual manufacturing conditions.

The George J. Hagan Co., Pittsburgh, Pa., have issued another of their series of bulletins on various types of industrial furnaces. This one which is entitled Standardized Heat Treating Furnaces, Combustion Type covers a line of standardized furnaces burning oil or gas, for steel hardening, carbonizing, annealing, and similar heat treating operations.

The Blast Furnace *and* Steel Plant

Pittsburgh, November, 1921.



Superior Steel Mill Bearings

These Hyatt roller bearings developed for steel mill equipment combine the best ideas of our engineers and of practical steel mill engineers throughout the country.

They are designed and constructed especially for use on ingot and charging cars and on the tables of blooming, plate, bar and structural mills.

The sturdy chrome-vanadium rollers assembled into a strong compact unit have endurance built into them that assures easy running cars and table rollers for years without adjustment or replacement.

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